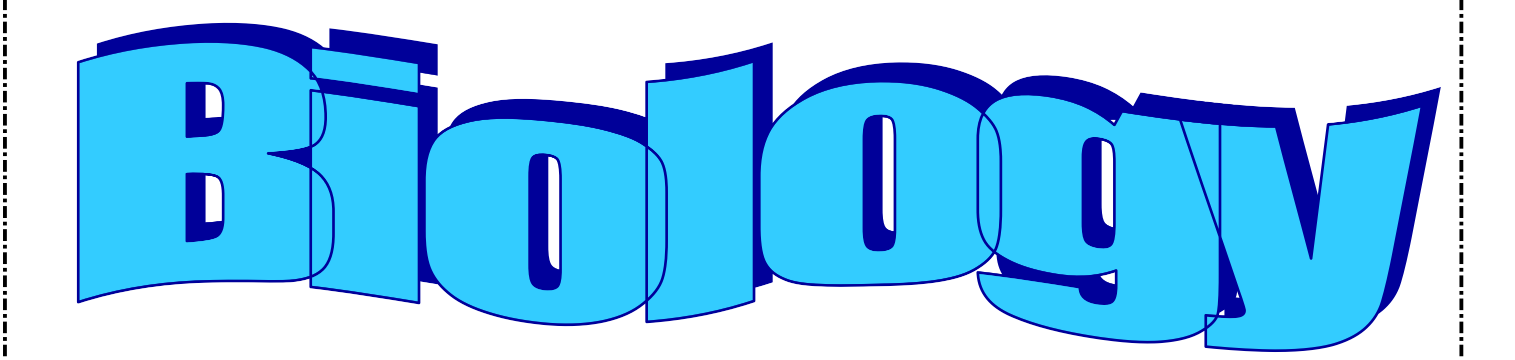
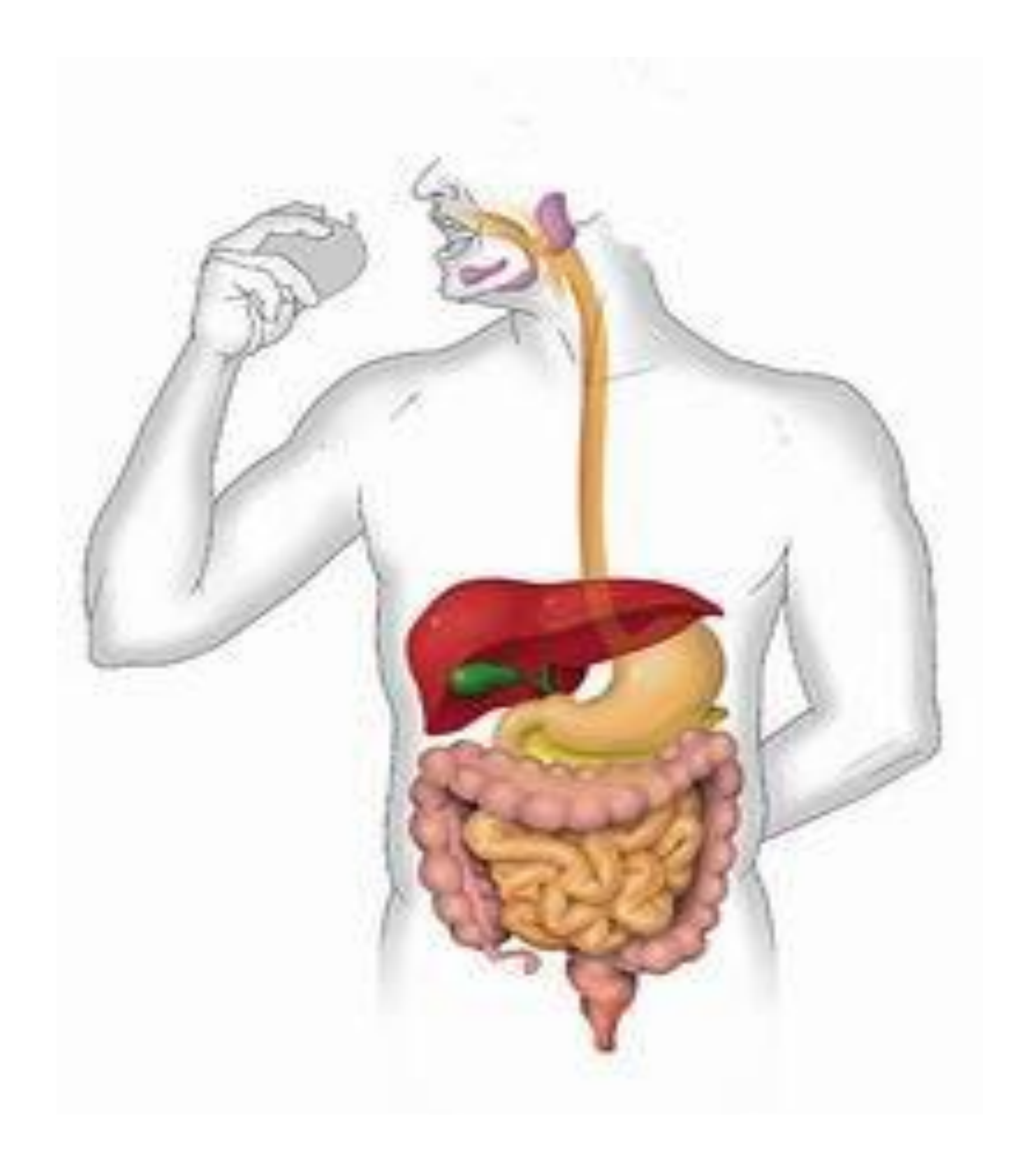


***Name:*...............................**

Class : 2/….

Unit (1)
Structure and function in living organisms
Chapter (1)
Nutrition and Digestion



https://youtu.be/08VyJOEcDos



Nutrition and Digestion In Living Organisms

Concept of nutrition:

It is the scientific study of food and various modes of nutrition of living organisms.

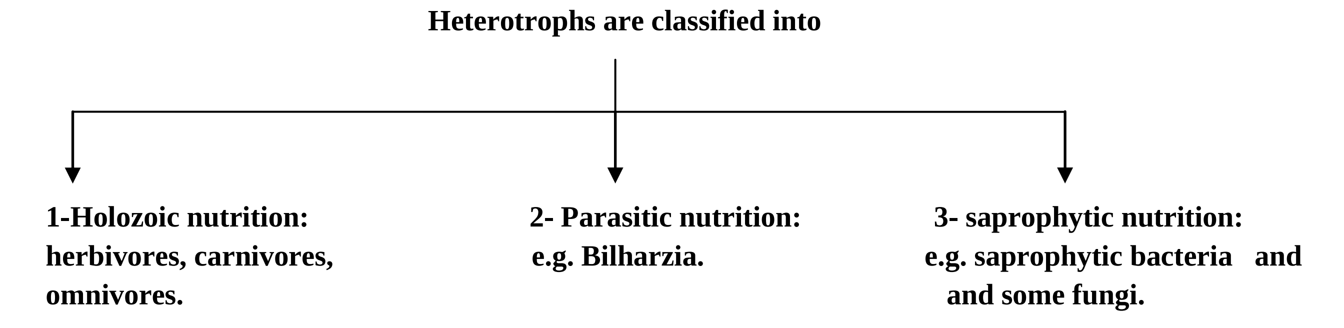
Nutrition is needed for:

a- Food materials are the source of energy for all vital processes.
b- Food materials are needed for growth and repair of worn out tissues.

Types of nutrition:

a- Autotrophic nutrition:
Autotrophs are living organisms which can manufacture their food by themselves e.g. green plants. They can synthesize inside their cells high energy food stuffs as carbohydrates, fats and proteins out of simple inorganic and low energy materials as $\mathbf{CO_2}$ and $\mathbf{H_2O}$ in addition to **minerals salts** and **light energy** by a process called **Photosynthesis.**

b- Heterotrophic nutrition:
Living organisms obtain food from other organisms either plants or animals that were previously feeding on plants.



Autotrophic nutrition

Nutrition in green plants:

Include 2 important processes:

1- The process of absorption of water and salts.
2- The process of photosynthesis.

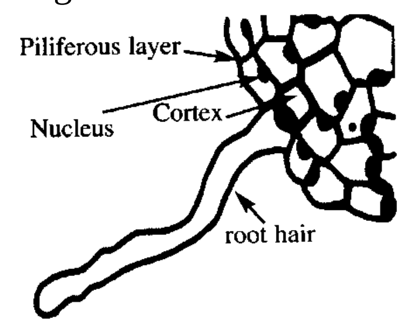
The process of absorption of water and salts:

Higher plants absorb water and minerals from the soil through root hairs present in the root system . This solution is then transported from one cell to another until reaching the xylem.



- **Structure of the root hair:**

1- Each root hair is a tubular outgrowth of an epidermal cell.
2- Root hairs are lined internally with a thin layer of cytoplasm which contain the nucleus and a large cell vacuoles .
3- A root hair may reach 4 mm long.
4- Root hairs don't exist for more than few days or weeks, since the epidermal cells are lost from time to time and are regenerated from the zone of elongation.



- **Adaptation of the root hairs to their function:**

1- They have thin walls to permit the passage of water and salts through them.
2- Large in number and protruding to the outside to increase the surface area of absorption.
3- They have high osmotic pressure: the solution of the cell vacuole is more concentrated than that of the soil in order to help water to pass from the soil to root hairs.
4- They secrete viscous substance to facilitate their passage among soil particles and help to fix the plant to the soil.

Mechanism of water absorption

It depends upon many physical phenomena:

1- **The phenomena of diffusion:**

Diffusion is the movement of molecules or ions from a high conc. medium to a low conc. one. This is due to the continuous free motion of molecules of the diffused substance e.g. diffusion of a drop of ink when it falls into a beaker containing water.

High conc. → molecules or ions → Low conc.

2- **The phenomena of permeability:**
It is the ability of some walls and cell membranes to allow the passage of both water and ions through them. So the walls and membranes divided into:
a- **Impermeable:** that impermeable to water and salts ions. e.g. walls that covered with lignin, suberin and cutin.
b- **Permeable:** that allow both water and salts ions to pass through them. e.g. cellulose walls.



c- **Semi-permeable:** that allow the passage of water and controls the permeability of many salts and prevents the others, such a phenomena is called **selective permeability**.
e.g. plasma membrane.

- **Selective permeability:**

The selective permeable membrane allows the passage of water, controls the permeability of many salts but it prevents the permeability of sugars and amino acids because they are large sized molecules.

3- The phenomenon of osmosis:

It is the diffusion of water from a medium with a high conc. of water to another with a low water conc. through a semi-permeable membrane.

- **Osmotic pressure:**

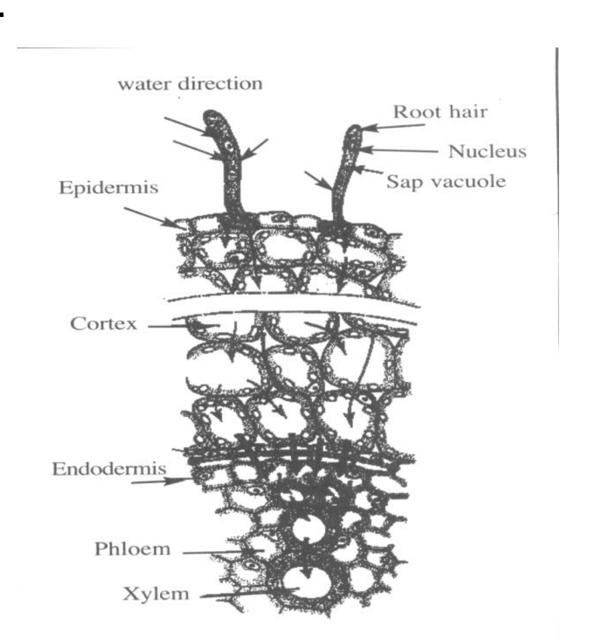
The pressure that causes the diffusion of water through semi-permeable membrane.
The osmotic pressure increases by an increase in the conc. of solutes (salts) in water.

4-The phenomenon of imbibition:

It is the ability of solid particles especially colloidal ones to absorb liquids, swell and increase in volume e.g. cellulose, pectin and proteins of protoplasm.

Absorption of water by root:

Passage of water Through the root cells



1-The outer surface of root hair are covered by colloidal layer that will **imbibe** water from the soil solution by **imbibition** and also the cellulosic walls will imbibe water from the soil solution.
2-The imbibed water is then withdrawn to the inside of the epidermal cells by **osmosis** due to the difference between the higher conc. of sugar in the cell sap and the lower conc. of
soil solution i.e. due to the difference in water conc. which is higher in soil solution than in the cell sap ,so water is withdrawn from the soil into the epidermal cells of the root by osmotic forces.
3-As a result the water concentration in these cells becomes higher than of



the neighboring cells of the cortex, so the movement of water continues from one cell to another until it reach the xylem vessels in the center of the root.

Notice:

The osmotic pressure of root hairs in xerophytes (deserted plant) and halophytes (salted plants) is high, reach 50 to 200 atmospheres, in order to help these plants to absorb as much water as possible from surrounding medium, so they can grow in salty soil. While the osmotic pressure in ordinary plants (mesophyte) is low, reach 5n to 20 atmospheres.

Pathways for passage of water from the soil to the xylem vessels:

Scientific researches proved that absorbed water passes across the root cells, until it reaches xylem vessels through 3 pathways:

1- Through **cell sap** by osmosis that needs a gradual fall of osmotic pressure along the root cells.
2- Through **cell walls** and through the small **intercellular spaces** by imbibition.
3- Through the **cytoplasm** where the water rushes from one cell to another through the **plasmodesmata** which connect the protoplasm of the plant cells together.

G.R: The endodermis has a major role in controlling the passage of both water and solutes to the xylem vessels.

The endodermal cells facing the phloem have their walls completely thickened with suberin, so water never passes through them by imbibition.

While the endodermal cells facing the xylem, suberin is found only as as a **casparian strip**, these cells are called passage cells, in these cells water passes through unthickened walls by **osmosis** under the control of protoplasm.



Endodermal cells faces the xylem



Absorption of mineral salts:

The plant needs carbon, hydrogen and oxygen beside other essential elements, they are divided into 2 groups:

1- Macro-nutrients:

- The plant need to these elements in considerable quantities
- They are 7 (Nitrogen- Phosphorus-Potassium-Potassium-Calcium-Magnesium-Sulphur and iron)

2- Micro-nutrients:

- The plant needs these elements in very small quantitiesm (not exceed few milligram/liter), so they are called **trace elements**.
- They are 8 (Aluminum-Boron-Zinc-Manganese-Chlorine-Copper-Molybdenum and Iodine)
- These elements help to activate enzymes.

Notice: Deficiency of macro and micro- nutrients would lead to:

a- Disturbance in plant growth which may even stop completely.
b- Stop production of flowers or fruits.

<u>Mechanism of absorption of minerals:</u>

The plant absorb minerals in the form of ions:

- **Positive ions called " Cations" such as K^+ and Ca^{++}.**
- **Negative ions called "anions" such as SO_4^{-2}, NO_3^- , Cl^-.**

These ions behave independently of each other and of water itself.

1- Diffusion:

As solutes move from high concentration in soil solution to low concentration by diffusion and also through the wet cellulose walls.
Under certain conditions, there is exchange take place between a Na^+ ion where it gets out of the cell and is replaced by a K^+ ion.

2-Selective permeability:

When ions reach a semi permeable plasma membrane, some ions are selected and allowed to pass inward according to the plant's requirements, **regardless of the size, concentration or charges.**

3-Active transport:

Sometimes, ions diffuse from the soil solution where the concentration of ions is low to inside the cell which is higher in concentration. Therefore, **energy** is needed to force these ions to move **against concentration gradient**.



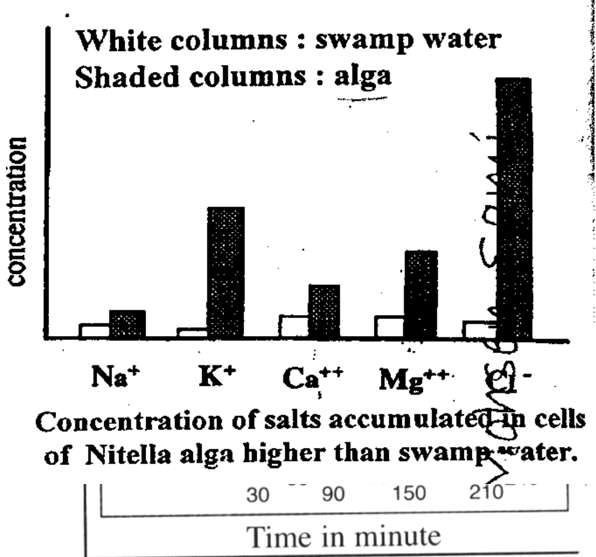
❖ **An experiment to measure the concentration of ions in swamp water and in cells of Nitella algae:**

-**Observation 1:** The conc. of various ions accumulating in the cell sap of Nitella algae is higher than their conc. in swamp's water.

-**Conclusion 1:** The cell must use up energy to absorb ions against conc. gradient.

-**Observation 2:** The conc. of some ions in the cells of the algae is higher than other ions.

- Conclusion 2: The ions are selectively absorbed according to the requirement of the cell.



Concentration of salts accumulated in cells of Nitella alga higher than swamp water.

So, The phenomena of active transport:

It is the passage of any substance through the cell membrane against concentration gradient by the help of some chemical energy that released during aerobic respiration of the plant tissue.

G.R, Both sugar and oxygen are essential for absorption of salts

-Since the process of aerobic respiration demands the presence of both sugar and oxygen to produce energy required to active transport of solutes.

❖ **An experiment to illustrate the relationship between the type of respiration in the root tissue and the rate of salts absorption.**

-Steps:

1- The barely plant was supplied with sulphate salts containing radioactive sulphur (S^{35}).

2-The quantity of absorbed salt was estimated by using Geiger counter in two cases, when

a- The root was exposed to aerobic condition.

b- The root was exposed to anaerobic condition.

Observation:

The quantity of absorbed sulphate ions (SO_4^{-2}) that containing radioactive sulpher (S^{35}) in the root of the barely plants is twice when the root is exposed to aerobic conditions while in anaerobic condition the quantity of absorbed ions was less.

Conclusion:

The energy that is used for absorption of salts against concentration gradient inside the root cells is released during aerobic respiration.



N.B:

The accumulation of salts' ions in the vascular bundle (xylem) by active transport would lead to an increase in the osmotic pressure of these tissue which help in water withdrawing by osmosis.

Comparison between diffusion and active transport:

Diffusion	Active transport
1- Non selective	1- Selective
2- Molecules move down concentration gradient.	2- Molecules move against concentration gradient.
3- Living membrane not essential.	3- Living membrane essential.
4- No energy is needed	4- Energy is needed
5- Example: diffusion of salts between soil particles	5- Example: Absorption of salts from soil by root hair cell.

The process of photosynthesis in green plants

The photosynthesis is one of the most important processes to man and also it is the principle foundation of life on earth because:

1- It produces man's food such as carbohydrates, proteins, fats and vitamins.
2- It is the source of oxygen which is about 21% of atmospheric air.
3- It produces plants and animal fiber that are used textile fibrils.
4- It is the source of industrial products such as fats, alcohol and vinegar.
5- It is the source of chemical energy stored in food which is required for all organisms.
6- It is the source of fuels such as coal, petroleum and natural gas.

<u>Raw materials required for photosynthesis:</u>

1- **Water:** is the source of **hydrogen** needed to reduce CO_2 to produce carbohydrates.
2- **CO_2**: Is the source from which the plant obtains **carbon**.
3- **Phosphorus**: is an important element in the structure of **energy carrier compounds (ATP).**
4- **Magnesium:** is required in the synthesis of **chlorophyll**.
5- **Iron:** is important for building up of **enzymes** to complete the photosynthesis.
6- **Mineral salts:** e.g. nitrate phosphates and sulphates are required to **convert carbohydrates into proteins**.

<u>The products of photosynthesis:</u>

a- <u>Monosaccharide:</u> is the **main product** of photosynthesis which can be
1- Used in the manufacture of proteins required for growth.
2- Broken down during the process of respiration to produce energy.
3- Converted into starch in order to be stored.

b- **<u>Oxygen</u>**: is the **secondary product** of photosynthesis.



Where does photosynthesis take place?

1- Green leaves: since higher green plants contain chloroplast.
2- Green herbaceous stems: as they contain chlorenchyma tissues having chloroplasts.

The structure of chloroplast

a- **Under the light microscope:** the chloroplast appears as a homogenous mass having a shape of **convex lens.**

b- **Under the electron microscope:**

1- The chloroplast is enclosed by a double thin membrane about 10 nanometer thick.
2- **The matrix (stroma):** inside the membrane, a colorless and proteinic substance.
3- **Grana**: embedded in the stroma, disc shaped, are linked together by thin membrane called " grana lamella"

Each granum is: about 0.5 in diameter and about 0.7 micron thick and made up of 15 or more disc arranged over each other.

Each disc is: hollow from the inside and its margin extends to meet the margin of another disc in the neighboring granum to increase the exposed the exposed surface area of the discs as they are responsible for carrying pigments that absorb light energy.

Notice:

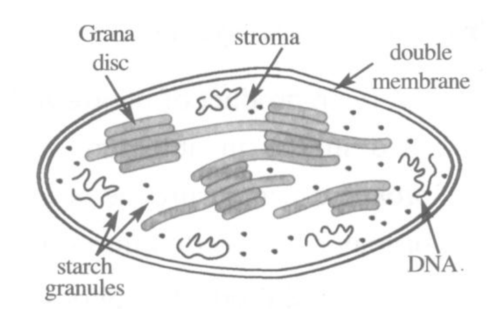
The starch grains are the temporary product of photosynthesis, are produced inside the chloroplast. They are small in size to easily change back to soluble sugar in order to be translocated, under certain condition, to other organs of the plant.

The chloroplast's pigments: there are 4 main pigments are present in the chloroplast.

Pigment	Colour	Percentage
Chlorophyll A	blue –green →	about 70%
Chlorophyll B	Yellow-green ↗	
Xanthophyll	Lemon- yellow	about 25%
Carotene	Orange-yellow	about 5%

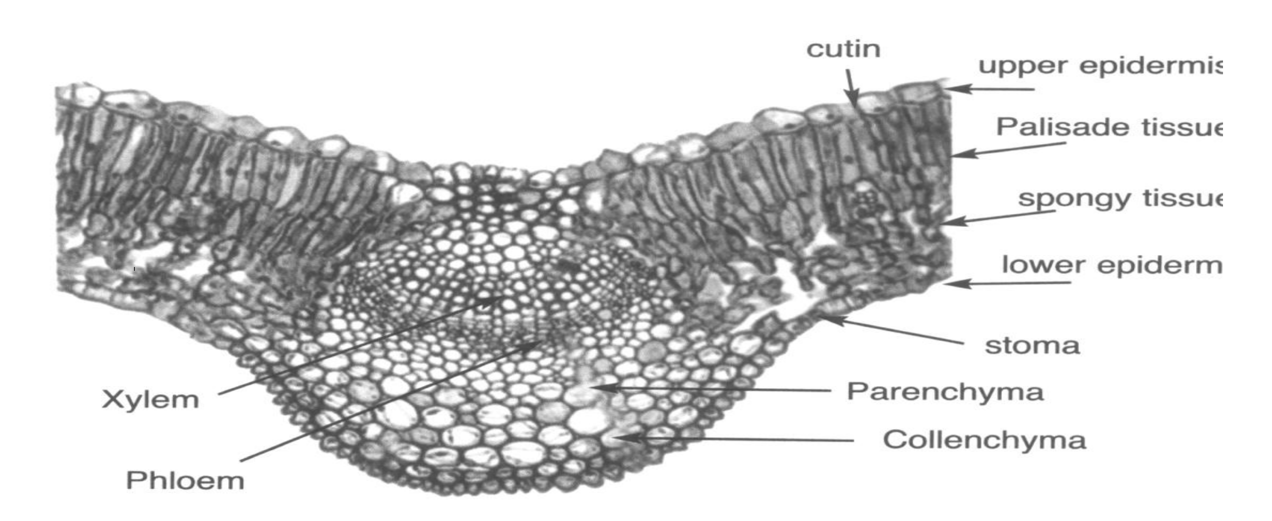
Notice:

1- The green color dominates of other pigments in the plastid due to the ratio of chlorophyll is about 70% which is important for absorption of light energy required for the photosynthesis.



2- The molecular formula of chlorophyll a is $C_{55} H_{72} O_5 N_4 Mg$, the magnesium atom occupies the center of molecules and it is believed that there is a relationship between the presence of Mg in the chlorophyll molecule and the ability of chlorophyll to absorb light.





Structure of the leaf and its adaptation to photosynthesis

The structure	The function adaptation
1- Leaves are flattened, its blade is thin, arranged on stem in a certain manner.	**1- In order to be exposed to receive the largest amount of sunlight.**
2- The leaf blade is supported by midrib which is branched into smaller veins forming a net which spread over the leaf blade.	**2- To supply the leaf with water and salts from the soil, also helps to translocate high energy food from leaf to any part of the plant.**
3- The leaf surface is covered with cutin.	**3- To prevent water evaporation from the plant.**
4- Has stomata that mostly open in the light and closed in the dark, also affected by the degree of humidity of environment.	**4- For gaseous exchange between atmosphere and the interior of the leaf and control the rate of water evaporation from plant.**

Structure of the leaf

Anatomical structure of the leaf and its adaptation to vital processes:

The leaf consists of three main tissues which are:

- The upper and lower epidermis.
- The mesophyll.
- The vascular tissue.

1- **The upper and lower epidermis** :Each layer consists of:

a- One raw of parenchyma, barrel shaped.

b- Has stomata.

c- Has no chlorophyll (transparent)

d- It is coated with a layer of cutin.



2- **The mesophyll:**

-Lies between the upper and lower epidermis and transversed by veins.

- Mesophyll consists of 2 layers :

a- The palisade layer:

- It consists of one raw of cylindrical , elongated parenchyma cells.
- The cells are perpendicular to the leaf surface.
- The cells posses many chloroplasts that can move freely to the upper part of the palisade cells to receive the largest amount of light.

b-Spongy layer:

- It lies below the palisade layer.
- It consists of irregularly shaped and loosely arranged parenchyma cells inbetween these cells there are wide inter-cellular spaces.
- It contains less number of chloroplasts than palisade cells.

3-The vascular tissue:

- It consists of many vascular bundles that extend inside veins and venules beside the main vascular bundle that present in midrib.
- Inside the vascular bundle there are several rows of **xylem vessels** facing the upper epidermis. These vessels are separated by xylem parenchyma .Xylem vessels supplies the mesophyll tissue with **water** and **salts**.
- The phloem lies towards the lower epidermis that translocates dissolved **organic food** from mesophyll where it is made to other parts of the plant.

Mechanism of photosynthesis

What is the source of oxygen evolved in photosynthesis?

Van Neil: the first person who pointed out the source of oxygen in photosynthesis by

studying photosynthesis in both green and purple bacteria which:

- Are autotrophic as they contain bacteriochlorophyll which is simpler in structure than ordinary chlorophyll.
- Live in swamps and ponds where hydrogen sulphide is abundant, hydrogen sulphide is
- the source of hydrogen used to reduce CO_2 in order to build up carbohydrates and sulphur
- is released.

1- Assumption of Van Neil:

a) In green and purple bacteria, light decomposed hydrogen sulphide into hydrogen and sulphur then hydrogen is used in certain dark reactions to reduce CO2 into carbohydrates as represented by the equation.

$$6CO_2 + 12H_2S \xrightarrow[\text{bacteriochlorophyll}]{\text{Light energy}} C_6H_{12}O_6 + 12S\downarrow + 6H_2O$$

b) In green plants, he assumed that light reactions in green plants is similar to those of sulphur bacteria, except that in green plants, water decomposed into hydrogen and oxygen, then hydrogen is used in the reduction of CO2 in a series of reaction don't require light to produce carbohydrates as represented by:

$$6CO_2 + 12H_2O \xrightarrow[\text{chlorophyll}]{\text{Light energy}} C_6H_{12}O_6 + 12\,O_2\uparrow + 6\,H_2O$$

2- <u>Scientists of California university:</u>

They confirmed the theory of Van Neil experimentally by using green chorella algae and provided it with all condition favorable for photosynthesis through two separated experiments:

1st exp: the water which was used contained the isotope ^{18}O instead of ordinary ^{16}O

$$6C^{16}O_2 + 12H_2{}^{18}O \xrightarrow[\textbf{Chlorophyll}]{\text{Light energy}} C_6H_{12}{}^{16}O_6 + 12\,O_2{}^{18} + 6\,H_2O^{16}$$

Observation: the evolved oxygen was O^{18} and not O^{16}

2nd exp: the water which was used contained the ordinary ^{16}O instead of isotope ^{18}O

$$6C^{18}O_2 + 12H_2{}^{16}O \xrightarrow[\text{Chlorophyll}]{\text{Light energy}} C_6H_{12}{}^{18}O_6 + 12\,O_2{}^{16} + 6\,H_2O^{18}$$

Observation: the evolved oxygen was O^{16} and not O^{18}

Conclusion: The two experiments prove that the source of librated oxygen is water and not carbon dioxide.

<u>Light and dark reactions:</u>

Blackman concluded that photosynthesis consists of two kinds of reactions,

1- Light reaction: in which light is the limiting factor of the rate of photosynthesis.
2- Dark reaction (enzymatic reactions): in which temperature is the limiting factor of the rate of photosynthesis and it is not affected by light.

Light reactions	Dark reactions
1- Take place in grana of the chloroplast.	**1- Take place in the stroma of the chloroplast.**
2- Sensitive to light.	**2- Not affected by light.**
3- Light is the limiting factor of the rate of of photosynthesis.	**3- Temperature is the limiting factor of the of the rate of photosynthesis.**

<u>First: Light reaction:</u>

1- When light falls on the chlorophyll of the grana inside the chloroplast, some electrons in the atoms of chlorophyll molecule will gain energy and shifted up from low energy levels to higher ones.
2- In this way the kinetic light energy is stored as potential chemical energy in the chlorophyll. The chlorophyll molecule is said to be in an excited or activated state.
3- When the stored energy is released, the electron fall once more to the lower energy levels and the chlorophyll will return to the stable state ready for another influx of light.



4- The energy stored in chlorophyll:

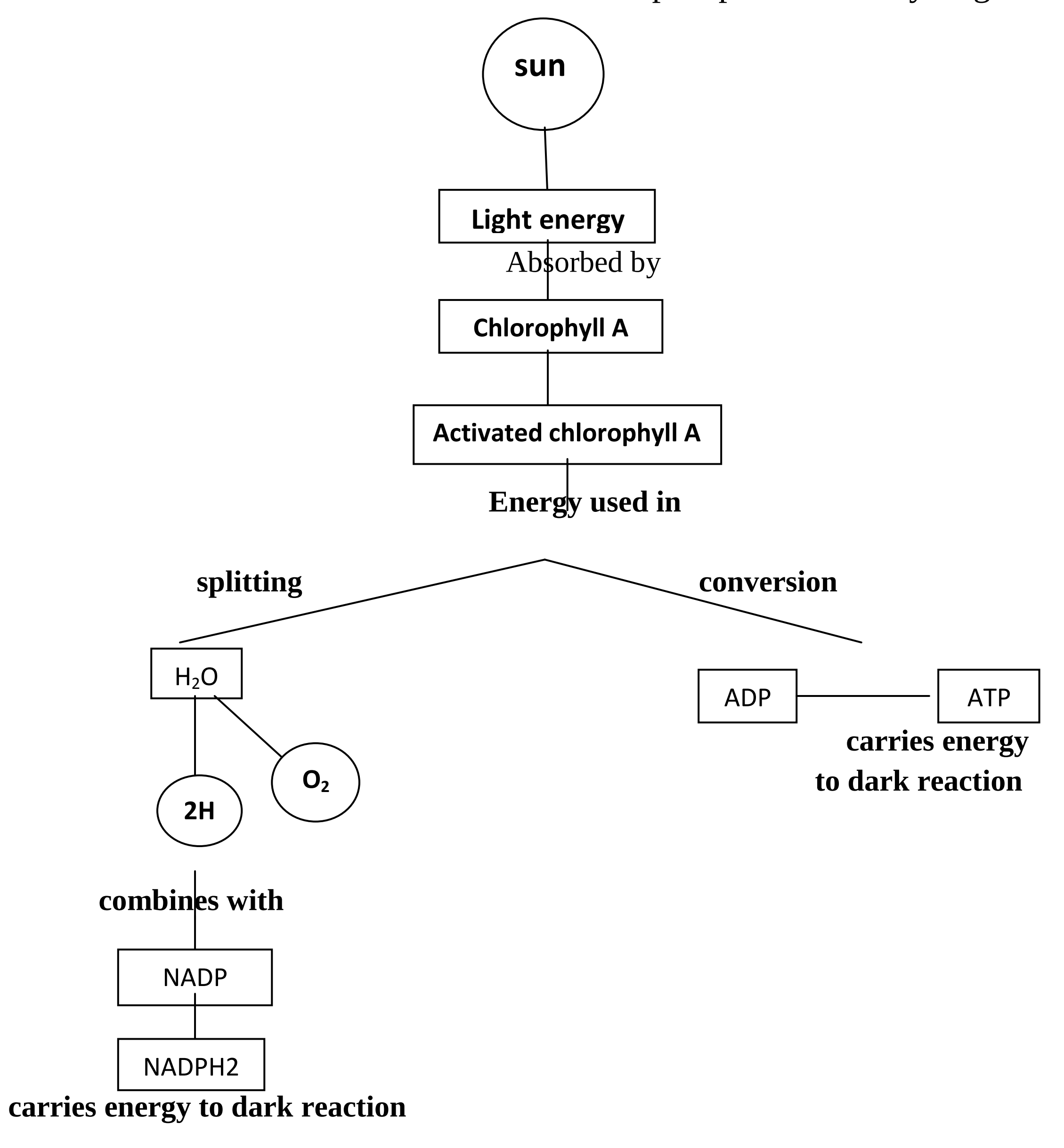
- Part of the stored energy is used in splitting up water molecule into hydrogen and oxygen which evolves as a byproduct. Hydrogen combines with co-enzyme present in the chloroplast (NADP) to give (NADPH2).

$$NADP + H_2 \longrightarrow NADPH_2$$

- Another part of energy is stored in ATP molecule as a result of combination of ADP molecule found in chloroplast with phosphate group (P).

$$ADP + P \longrightarrow ATP$$

- ATP : acts as energy currency in living cells. It is a compound called adenosine triphosphate consists of 2 organic compounds joined to achain of 3 phosphate groups. These two compounds are adenine and a sugar called ribose. The 3 phosphate groups are linked together by high energy bond.
- NADP: Nicotineamide adenine dinucleotide phosphate act as hydrogen receptor.



Second: Dark reactions:

In these reaction hydrogen carried on $NADPH_2$ tends to fix CO_2 gas into carbohydrates by helping the energy that stored in ATP molecules.

Melvin Calvin experiment:

He revealed the nature of dark reaction by using radioactive isotope of CO_2 gas containing radioactive C^{14}.

1- He placed the chlorella algae in a special apparatus as in the diagram and supplies it with CO2 containing radioactive carbon (C^{14}) and the lamp was shone very briefly in order to allow photosynthesis take place.
2- Chlorella was immersed in a beaker containing hot alcohol to kill the protoplasm by stopping its biochemical reaction.
3- He determined the products of photosynthesis by tested the radioactive carbon in these compounds by using **Geiger counter.**

Results of Melvin Calvin experiment:

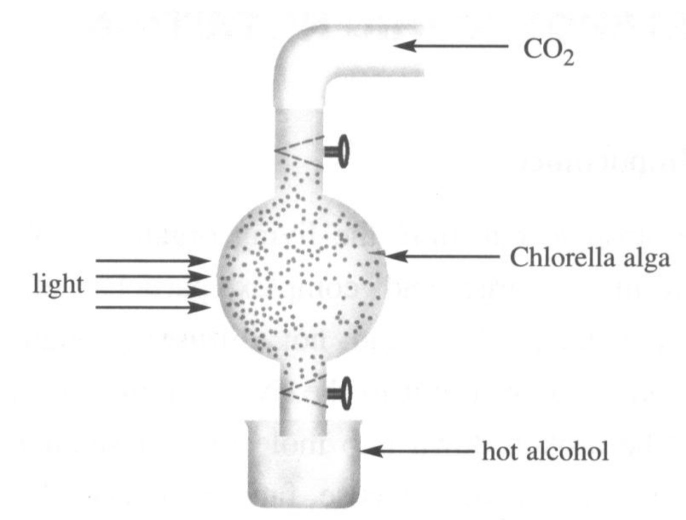
When photosynthesis occurs with briefest flash about 2 seconds, a 3 carbon compound was formed is **phosphoglyceraldehyde "PGAL"** that is the **first stable compound** produced in photosynthesis.

The uses of PGAL:

1- Production of glucose, starch, proteins and fats.
2- Can be utilized in cellular respiration as a high energy compound.

Notice:

- **ATP:** Adenosine triphosphate" acts as energy currency in living cells"
- **ADP:** Adenosine diphosphate.
- **NADP:** Nicotinamide Dinucleotide Phosphate "act as hydrogen receptor"
- **Calvin** pointed out that synthesis of a hexose sugar is not completed in one step, but throughout several intermediate reactions catalyzed by specific enzymes.





Heterotrophic nutrition

Concept of digestion:

It is the conversion of large food molecules **(polymers)** into smaller ones**(monomers)** by means of hydrolysis, this process are catalyzed by **enzymatic action**.

Notice:

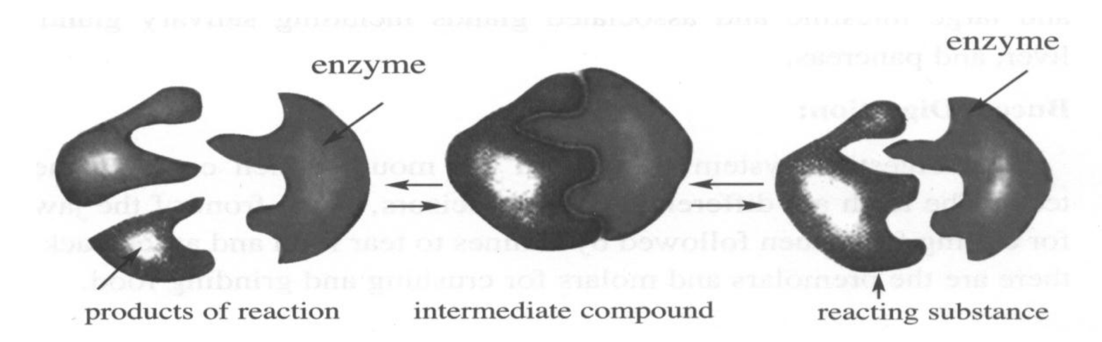
- Large complex such as proteins, starch and fats.
- Small molecules as amino acid, glucose, fatty acids and glycerol which are soluble in water, so they are easily absorbed by diffusion or by active transport in the cells that use these simple compounds the source of energy or in growth of new tissues.

- **Enzymes:**

The enzyme is a proteinic substance, has the properties of a catalyst which has a specific ability to activate a particular chemical reaction.

N.B:

The reaction is completed, the resulting molecules break away from the enzymes leaving the enzymes in the same from as it was before the reaction.



Properties of the enzymes:

1- They never affect the products of the reaction but they only accelerate the rate of reaction until it reaches a case of equilibrium.
2- Some enzymes have **a reversible effect** where the enzymes may catalyze the decomposition of a complex molecule into two simple molecules and also the same enzymes recombine the two small molecules (products) to give the same complex molecules once more.
3- Some enzymes are secreted in an inactive state, therefore they need certain a substance in order to activate them such as pepsin which is secreted in an inactive form called pepsinogen in the stomach . The presence of **HCL** acid in the stomach is necessary to convert **inactive pepsinogen** to **active pepsin**.
4- They are **specific** in their function.
5- The rate of reaction which is catalyzed by enzyme depends on **temperature** and **PH** value.



Digestion in Man

The human digestive system is built up of a long tube extending from the mouth to the anus. It starts with mouth , pharynx, oesophagus, stomach, small intestine and large intestine and anus beside the accessory glands which include salivary glands, liver and pancreas.

❖ **Digestion in the mouth (buccal digestion)**

1- The mouth contains:

a- The teeth:

- Incisors: for cutting the food.
- Canines: for tearing the food.
- Premolars and molars: for crushing and grinding food.

b- Tongue:

- Helps to manipulate the food to be chewed by the teeth.
- Helps to mix food with saliva.
- Acts as an organ of taste.

c- Three pairs of salivary glands:

- Secrete saliva through ducts which open into the mouth.
- Saliva contains mucus which help lubricate and swallow food.
- Saliva contains the enzyme amylase (ptyalin) which catalyzes the hydrolysis of starch to disaccharide.

Starch (polysaccharide) $\xrightarrow[\text{Weak alkaline medium}]{\text{amylase}}$ Maltose (disaccharide)

2-Pharynx:

Is a cavity at the back of the mouth which leads to two tubes the oesophagus and trachea (a part of the respiratory system).

-What is meant swallowing?

Swallowing is an organized reflex action when food is pushed from the mouth to the oesophagus , the top of the trachea and the larynx is elevated causing the epiglottis to close the glottis.

2- The oesophagus:

- 25 cm long, extends through the neck and the chest cavity.
- It lies parallel to the vertebral column.
- It is lined with glands secreting mucus.
- Food is carried through the oesophagus to the stomach by a series of rhythmical muscular contraction and relaxation named **peristalsis.**

-What is meant by peristalsis? It is a series of muscular contractions and relaxations which extend downward along the alimentary canal, so it plays a role in sweeping food, churning food with the digestive juices and absorption of food.



❖ Digestion in the stomach (gastric digestion):

3- The stomach:

-It is a swollen muscular sac lies in the abdominal cavity.- Separated from the oesophagus by a circular muscle called **cardiac sphincter**.
- Separated from the small intestine by a constricted circular muscle called **pyloric sphincter.**

The gastric juice:

- Colourless, acidic liquid consists of 90% water and 10% HCL and digestive enzymes.
- Proteins are the only food which is affected with gastric juice.

- **The importance of HCL:** creates an acidic medium (1.5 to 2.5 PH) that help to:

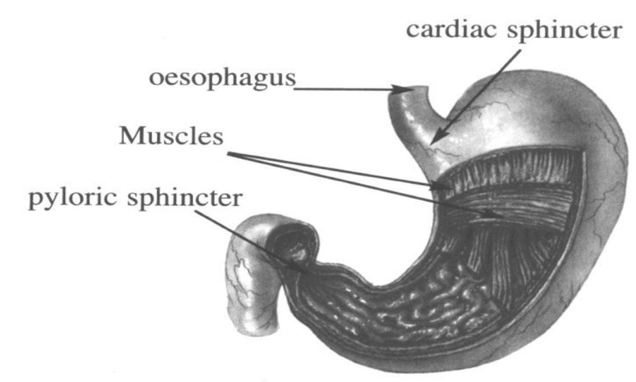
1- Stops the action of ptyalin enzyme.
2- Kill harmful microbes.
3- Activates the gastric enzyme inactive pepsinogen that becomes active pepsin that catalyses the hydrolysis of protein by breaking peptide bonds in the long chain of the protein to yield smaller fragments called polypeptides (peptones) .

$$\underset{\text{(inactive)}}{\text{Pepsinogen}} \xrightarrow{\textbf{HCL}} \underset{\text{(active)}}{\text{Pepsin}}$$

$$\text{Protein + water} \xrightarrow[\textbf{HCL}]{\textbf{pepsin}} \text{polypeptides (peptone)}$$

Adaptation of the stomach to its function:

1- The muscular contraction of the stomach wall help in churning and mixing the food with gastric juice.
2-Stomach stores food for a long time enough to be digested. (Bec, stomach is large enough to store food).
3-The food in the stomach becomes a heavy acidic semi fluid called Chyme which is discharged at intervals into the small intestine by relaxation of the pyloric sphincter.



- **Why gastric juice does not affect the epithelial layer of the stomach?**

4-Due to the presence of copious mucus secretion which protect the cells against the effect of digestive enzymes.



5-Pepsin is secreted in an inactive state called pepsinogen which will be activated only when it is mixed with HCL acid in the stomach cavity.

❖ Digestion in the small intestine (Intestinal digestion):

5-<u>Small intestine:</u>

- About 8 meter long and about 3.5 cm in diameter at its beginning to 1.25 cm at its end. It consists of duodenum and ileum.

- Coils and loops of the small intestine are connected together by the mesentery

(**mesenteric membrane**).

- The **bile, pancreatic, and intestinal juices** are the juices that help to digest food in the **small intestine.**

a- The bile juice:

- Liver secretes bile, stored in the gallbladder, when gallbladder contract it forces bile into bile duct then to duodenum on chyme.

- Helps to convert fats into fatty emulsion **i.e** dividing large masses of fats into small globules so it facilitates enzymatic action on fats which are in soluble in water.

b- Pancreatic juice:

Pancreas secretes pancreatic juice which passes to pancreatic duct then to duodenum on chyme.

1- Pancreatic amylase: catalyze the hydrolysis of glycogen (animal starch) and starch into maltose in alkaline medium.

$$\text{Glycogen and starch} \xrightarrow{\text{pancreatic amylase}} \text{maltose sugar}$$

2-Sodium bicarbonate: ($NaHCO_3$)

It neutralize Hcl acid and renders the medium alkaline (PH 8).

3-Trypsinogen:(inactive enzyme)

It is activated inside the duodenum into active trypsin by the action of **Enterokinase** co-enzyme secreted from cellular wall of small intestine.

Trypsinogen —**Enterokinase (co- enzyme)**→ **Trypsin**

Trypsin: helps in breaking down proteins into polypeptides.

Proteins —**Trypsin**→ **Polypeptides**

4-Lipase enzyme: catalyzes the hydrolysis of emulsified fats into fatty acids and glycerol.

Emulsified fats —**Lipase enzyme**→ **fatty acids + glycerol**

C – Intestinal juice:

-It is secreted by certain cells in the wall of small intestine.

- It contains the following enzymes that complete the action of various enzymes and end the process of digestion.

1-Peptidase:

It is a number of enzymes, each enzyme is concerned with the hydrolysis of peptides bond between certain kind of amino acid in the polypeptide chain.

Polypeptides —Peptidases→ amino acids

2-**Enzymes that hydrolyze disaccharides to monosaccharides:**

i- **Maltase:**

Maltose —Maltase (**in alkaline medium**)→ 2 mol. Of glucose

ii- **Sucrase:**

Sucrose (cane sugar) —Sucrase (**in alkaline medium**)→ glucose + fructose

iii- **Lactase:**

Lactose (milk sugar) —Lactase (**in alkaline medium**)→ glucose + galactose

3- **Enterokinase:**

It is not from digestive enzymes, it only acts as co-**enzyme which activates trypsinogen .It is secreted by intestinal glands in the wall of small intestine.**

The following table shows a summary of digestion in man:

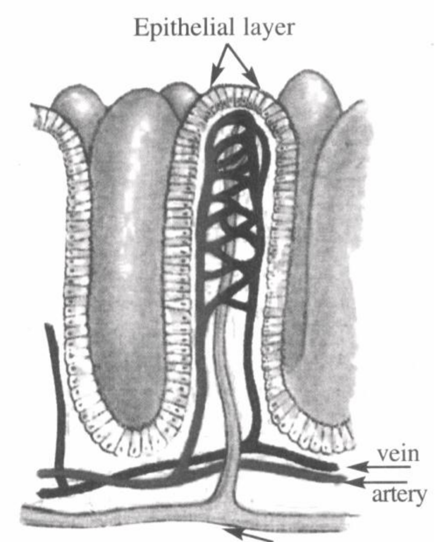
Secretion	source	Site of action	Enzymes & components	Reacting substances	products
Saliva (weak alkaline)	Salivary glands	Buccal cavity	ptyalin	starch	maltose
Gastric juice (acidic PH= 1. to 2.5)	Stomach	stomach	HCL HCL+ Pepsin	Pepsinogen protein	Pepsin polypeptides
Bile alkaline PH=8	liver	duodenum	Bile (non enzymatic)	fats	Emulsified fats
Pancreatic Juice Alkaline PH=	pancrease	duodenum	Amylase Trypsinogen	Starch& glycogen Inactive enzyme	Maltose Polypeptides



			Trypsin lipase	Protein Emulsified fats	Fatty acid+ glycerol
Intestinal Juice Alkaline PH=	Wall of Small intestine	Small intestine	Enterokinase Maltase Sucrose Lactase peptidase	Trypsinogen Maltose Sucrose Lactose polypeptides	Trypsin 2 glucose Glucose+fructose Glucose & Galactose. Amino acid

Absorption

It is the transfer of digested food substance through the epithelial cells of the ileum to the blood and lymph.



Structure of the small intestine wall:

1- Has many folds called villi that increase the surface area of the small intestine for the absorption of nutrients.
2- The surface area for the absorption of nutrients reaches about 10 m2, i.e about 5 times of the human body surface.

Structure of the villi:

Each villus consists of outer covering of a single layer called epithelial cells which enclose a lacteal vessel surrounded by a network of both venous and arterial blood.

The electron microscope pointed, the epithelial cells of the villi have tiny projections called micro- villi help to increase the surface area for the absorption of nutrients.

Products of digestion are transferred to the blood and lymph by the phenomena of **active transport** and **diffusion**.

Routes of absorbed food in the villus:

- **Lymphatic route:**

a- Fatty acid, glycerol and with their contents of vitamin k, D, A.
b- Some fatty acids and glycerol may recombine in the epithelial cells to form fats again.
c- Some emulsified fats don't hydrolyzed by enzymes are absorbed directly by being engulfed by epithelial cells.

All these materials pass into the lacteals and then to the lymphatic system which carries them slowly and empties them into the superior vena cava of the heart.

- **Blood route:**



Starts with the blood capillaries inside each villus, where blood carries water , mineral salts, monosaccharides, amino acids and water soluble vitamins to hepatic portal vein, then to the hepatic vein into the inferior vena cava and then to the heart.

6-The large intestine and defecation:

1-The undigested food passes to the large intestine.

-The most important function of the large intestine is the absorption of water and salts from the undigested food due to the presence of many convolutions help in this process.

2-The undigested food becomes a semi-solid.

-Presence of bacteria in the large intestine is responsible for the bad odour and breakdown of these remains into simple substance.

3-Wastes remains are expelled as feaces through the anus by means of strong muscular contraction of the rectum accompanied by relaxation of the two muscles of anal sphincter on both sides of the anus.

-The large intestine secretes mucus that facilitates passage of undigested food to exterior.

Metabolism:

It is a process where the body benefits from the absorbed digested food. It includes two opposite processes:

1- Anabolism:

In this process simple food substances are converted into complex substances which enter in the structure of the body e.g glucose is converted into glycogen stored inside liver and muscles.

2- Catabolism:

Break down (oxidation) of the absorbed food substances especially carbohydrates to produce energy needed for the vital processes of the body.



Chapter (1) questions

1-Write the scientific term for each of the following:-

a-Disk shaped granules extend in piles inside the plastids.   (………………..)

b-The first stable compound as a result of photosynthesis. (…………………)

d- A part of chloroplast at which the dark reaction take place. (…………………..)

e-A compound gives oxygen by its splitting up during the photosynthesis.

(……………….)

f-An important element in the structure of compounds which carry energy during photosynthesis.   (……………..)

2- Give reason for:-

1-Root hairs regenerated continuously.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

2-The upper surface of the leaf is greener than the lower.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

3-ATP and NADH2 are collectively called energy fixing compound.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

4-The green colour dominates over the other pigments in chloroplast.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

5-Garistric juice does not affect the lining cells of the stomach.

……………………………………………………………………………………………………

……………………………………………………………………………………………………



3-What is the function of the followings:-

1-Large intestine.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

2- The bile.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

3-Amylase.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

4-HCl in the Stomach.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

4-What happens when:-

1-Pancreatic juice doesn't contain Sodium Bicarbonate.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

2-Absence of mesophyll layer from the plant leaf.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

3-Decreasing the temperature of plant under the normal value.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

4-Removal of small intestine.

………………………………………………………………………………………………………

………………………………………………………………………………………………………



Chapter (2)



Transport in Living Organisms

https://youtu.be/uKdZVt1vBlQ

Transport in livings.

Concept of transport and the need for it:

Living organisms obtain what they need for feeding of various substances by different means:

In case of plants:

The green plant requires a supply of CO_2, H_2O, and mineral salts in order to carry out photosynthesis:

1. In primitive plants as algae: These raw materials, together with products of photosynthesis move from one cell to another by diffusion and active transport. So, they are in no need for a specialized transport tissues.

2. In higher plants: Gases are transported by diffusion, while water, mineral salts and soluble products of photosynthesis are transported by means of a specialized vascular tissues.

In case of animals:

Animals obtain their energy requirements in the form of food. After digestion of food, the soluble digested food substances are absorbed. These substances have to be transported to be distributed to various tissues that lie away from surface of absorption:

1-In small animals as Protozoan and Hydra: Both respiratory gases and food substances move by diffusion.

2-In bigger and more complicated animals: Diffusion is not enough for transporting food and oxygen to various tissues. Therefore, the presence of a specialized transport system is essential in these animals.

Transport in higher plants:

1. Water and mineral salts:

Are absorbed by the root hairs and translocated across the root tissues, until they reach xylem vessels of the root. They are carried through the xylem of the stem to that of the leaves. Leaves carry out photosynthesis and produce high-energy carbohydrates, fats, and proteins.

3. High-energy carbohydrates, fats, and proteins:

Are transferred from centers of their manufacture to sites of storage and consumption in various tissues (roots, stems, fruits, and seeds). They pass through the sieve tubes in

the phloem of the leaf, the stem, and the root.

Examination of a transverse section



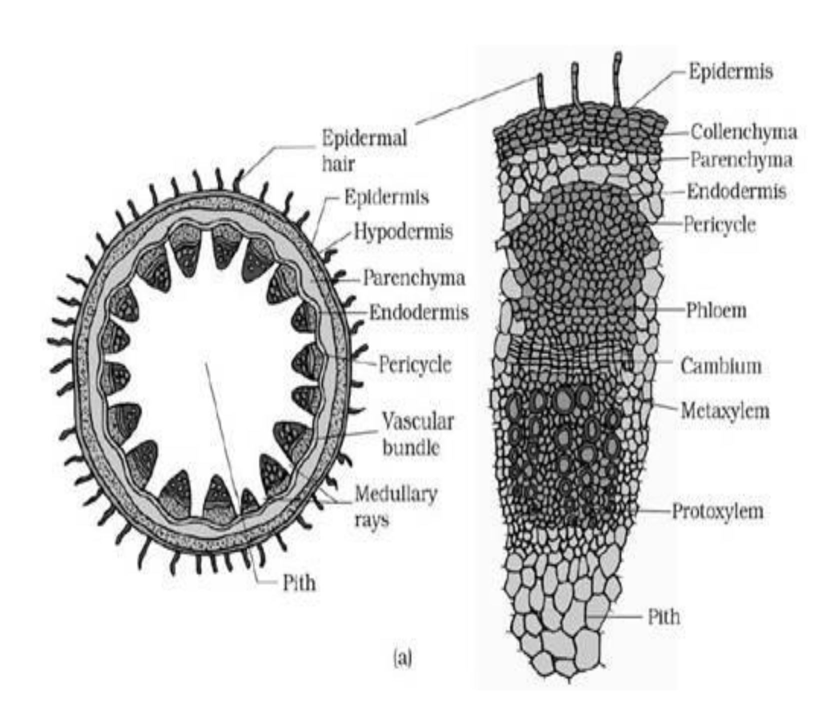
in a young stem of a dicotyledonous plant.

1.The epidermis:

One row of adjacent, barrel-shaped parenchyma cells, their outer walls are thickened with a layer of cutin.

2.**The cortex:**

Is composed of several rows of **collenchyma** cells which their corners thickened with cellulose. So they have supporting function. These cells may contain chloroplasts, so they take part in photosynthesis. These cells are followed internally with several rows of **parenchyma cells** with plenty of intercellular spaces for aeration. The innermost row of the cortex is known as the **starch sheath** for the storage of the starch grains.



2.The vascular cylinder:

Occupies a large space in the stem. It consists of:

A. The pericycle:

Groups of parenchyma cells that are alternated with sclerenchyma cells (plant fibers). Each group of plant fibers lies next to a vascular bundle externally. To support the stem and to make it erect and flexible.



B. The vascular bundles:

Arranged as a circle. Each is a triangular in its shape that its base is directed outwards. Each vascular bundle contains the following tissues from out inwards:

(1) **Phloem**: Is the outer tissue in the vascular bundle. It consists of sieve tubes, companion cells, and phloem parenchyma. Its function is to transport the organic food substances.

(2) **Cambium:** One row or more of meristematic cells that lie between xylem and phloem. Cambium cells divide giving **secondary phloem outwards** and **secondary xylem inwards.**

(3) Xylem: Is the inner tissue in the vascular bundle. Its function is to transport water and dissolved salts. It supports the stem as well

C. Pith:

Exists at the center of the stem. It is composed of parenchyma cells for food storage.

D. Medullary rays:

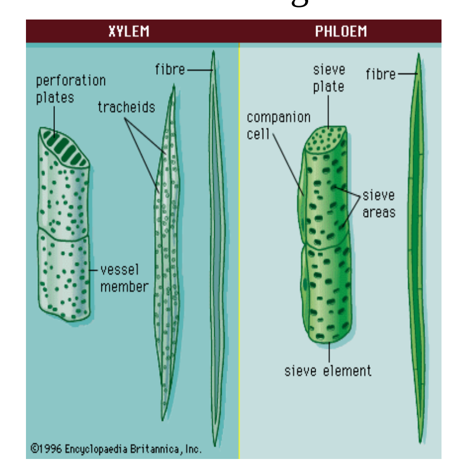
Extend between the vascular bundles, and connect the cortex with the pith in the form of parenchyma cells.

Structure of the xylem:

Xylem tissue contains the following transporting elements:

a) Vessels:

The vessel is formed of a chain of elongated cylindrical cells that are connected end to end. During the first stages of its formation, the transverse walls of these cells have completely dissolved, at the same time, the cellulosic walls have thickened with lignin which is impermeable for water and solutes. The protoplasmic contents of these cells have died leaving a hollow tube. Many pits are scattered all over the wall, where the primary wall is left without thickening. Pits allow water to pass from the inside of the vessel outwards. At the lining of the xylem vessels, strands of lignin taking various forms (sometimes spiral-shaped or annular) are seen. They support the xylem vessel and prevent the collapse of its wall.





❖ **G.R: Xylem vessel are adapted to their function.**

b) Tracheids:

They are similar to vessels except:

-They appear in the T.S as pentagonal or hexagonal.

(vessels appear circular in the T.S)

-They have pointed sharp and closed ends which are pitted. (Vessels are opened with no transverse walls.

❖ **Compare between xylem vessels and tracheids**.

Vessels	Tracheids
1- Open at both ends.	1- Closed pointed ends.
2- Appear cylindrical in T.S.	2- Appear pentagonal or hexagonal in T.S.
3- They are pitted.	3-They are pitted.
4- They are lignified.	4-They are lignified.
5- Translocate water and salts.	5-Translocate water and salts.

c) Xylem parenchyma:

Rows of parenchyma cells that are present between xylem vessels.

N.B

Its noticeable that xylem of the vascular bundles of the stem communicates with that of the root and the leaves. Similarly, phloem of the vascular bundles of the stem communicates with that of the root and the leaves. So, a network of vessels spread all over the plant.



Mechanism of transport from the root to the leaves

Factors responsible for ascent of sap.

The xylem is responsible for the translocation of water and mineral salts from the root to the leaves. Several theories were put forwards to explain the ascent of this sap in the plant:

1. Root pressure theory:

Exudation:

If a plant stem is cut very near to the soil level, exudation of water from the stump occurs. This phenomenon is called exudation. It is due to the root pressure continuing to force water up the plant, which is due to the osmotic pressure mechanism that exists in the root tissues. So, water is forced vertically upwards through xylem vessels for a short distance to a certain level, at that level, ascending of water stops. Because the opposing pressure of the water column in xylem vessels has become equal to the root pressure.

Disadvantages of root pressure theory:

1. Experiments prove that there is no reasonable explanation of ascent of water to high levels in tall trees by root pressure.

2. The maximum root pressure doesn't exceed 2 atmospheres.

3. Pinus and other conifers have no root pressure.

4. The force of root pressure is affected quickly by external factors.

2. Imbibition theory:

The colloidal nature of the walls of xylem vessels (that is formed of cellulose and lignin) has allowed these walls to imbibe water.

Disadvantages of imbibition theory:

This phenomenon has a very limited effect in sap ascent because experiments have proved that water ascends through the cavities of xylem vessels not along their walls.

The importance of this phenomenon is restricted to transport of water along the cells walls until it reaches the walls of vessels and tracheids in the root, also from these vessels and tracheids to the neighbouring cells in the leaves.

3. Capillarity theory:

Water rises through tiny tubes by capillarity. Xylem vessels are considered as capillary tubes with a diameter of 0.02 mm up to 0.5 mm. Water will rise in these vessels by the phenomenon of capillarity.



Disadvantages of capillarity theory:

Capillarity has a weak secondary effect in sap ascent because the finest capillary tube doesn't allow the rise of water more than a height of 150 cm.

4. Transpiration pull, cohesion and adhesion theory:

This theory were put forward by H.H. Dixon and J. Joly in 1895. It states that:

Water column ascends through xylem vessels depending on three principal forces that pull water upwards to very high levels that may reaches 100 meters.

These three principal forces are:

a. Cohesive force:
The strong mutual attraction between water molecules inside xylem vessels and tracheids. This explains the existence of a continuous column of water.

b. Adhesive force:
That exists between water molecules and those of the walls of xylem vessels. It helps the water column to be held against gravity.

c-Transpiration pull:

That attracts the water column upwards due to the continuous process of transpiration in the leaves.

Water has a high pulling force inside tubes under the following conditions:

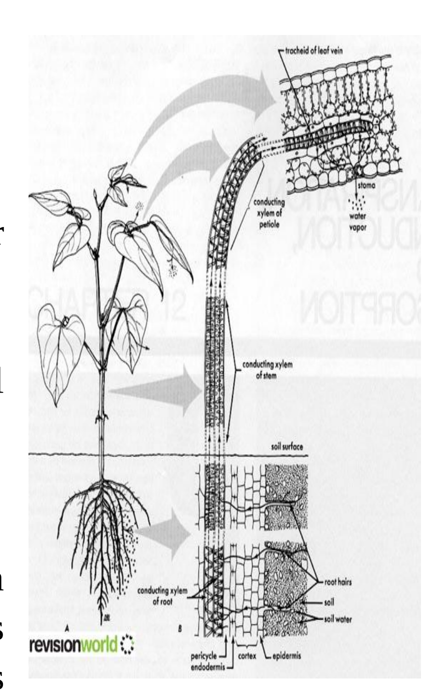
1. The tube must be capillary.
2. The walls of the tube must possess an adhesive force to attract water.
3. The tube must be free of any gas or air bubbles. (to avoid any breaking and descending of the water column)

All these conditions exist in xylem vessels

G.R.: Some seedlings, when transplanted from a nursery to an open air, fail to grow if they remain exposed to the sun for a long time before they are transplanted in the new soil.

Because this leads to their dryness and let the air bubbles to enter the xylem vessels breaking and descending water column.





Path of the sap during its ascent from the root to the leaves

1. Transpiration lessens the water concentration in the air chamber above the stoma in
the leaf.
2. Evaporation increases from the cells of the mesophyll surrounding the stomata chamber.
3. The water content of these cells decreases, and
the concentration of solutes inside them increases.
4. A diffusion pressure gradient for water is created. (i.e. a pulling force that attracts water from the surrounding cells that will continue as far as the xylem elements in the venules and veins, then finally from the mid-rib of the leaf)
5. Water ascends, under great force, through xylem vessels and tracheids of both the stem and the root as they are connected to one another.

N.B.: Transpiration pull of the leaf will not only pull water that has reached the vascular cylinder of the root up, but it will also help in the lateral pull of water from the soil by means of the root hairs.

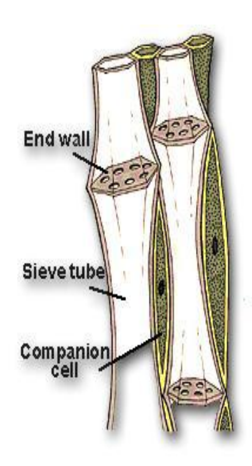
Transport of manufactured food from the leaves to other parts of the plant.

The phloem translocates the manufactured food (which consists of high energy organic substances produced by the leaves during photosynthesis) in all directions upwards in order to feed buds, flowers, and fruits, and downwards in order to feed the stem and the root system.

The role of sieve tubes in transport:

The phloem tissue consists of:

1. Sieve tubes:



Sieve tubes appear in the longitudinal section as elongated cells arranged end to end. They contain cytoplasm without a nucleus. The sieve tubes are separated from each other by cross walls (sieve plates) which are perforated by tiny pores, through which cytoplasmic strands extend from one tube to another.



2. Companion cells:

Each sieve tube has a nucleated companion cell. Vital functions of the sieve tube are organized by ribosomes and mitochondria present in the companion cell.

3. Phloem parenchyma:

Parenchyma cells join sieve tubes and companion cells together.

Experiments have proved that the role of the sieve tubes is the transport of ready-made food substances to various parts of the plant. These experiments include

the following:

A. Rapeden and Bohr experiment:

They supplied green bean leaf with CO_2 gas (containing radioactive Carbon C_{14}) in order to carry out photosynthesis and to produce carbohydrates. These carbohydrates being radioactive could be traced during their path in the plant. It was discovered that they are translocated upwards as well as downwards in the stem.

B. Mettler Experiment:

He managed, using the Aphid insects to describe the contents of sieve tubes in order to identify these contents. Aphid insect penetrates the tissues of the plant until it reaches the sieve tubes using its piercing mouth parts.

During the process of feeding the scientists separated the whole body of the insect from its mouth parts. In this way He managed to collect a sample of the sieve tubes contents. By analyzing this sample, it was shown to consist of the same organic substances manufactured in the leaves (sucrose and amino acids). To make sure that this was the phloem contents, He sectioned the region of the plant where the proboscis of the insect was inserted. It appears to be inserted in a sieve tube.

C. Thain and Canny Experiment:

Transport of organic substances in the phloem:

Thain and Canny could see long cytoplasmic threads which contain organic substances inside the sieve tubes and these threads extend through tiny pores from one tube to another.

They explained the transportation of the organic substances in the phloem on the basis of cytoplasmic streaming (The cytoplasmic circular movement inside the sieve tubes and



companion cells) during that the organic substances translocate from one end of the sieve tube to the other end, and then they pass to the other neighbouring sieve tubes through the cytoplasmic threads.
They explained that this activity (cytoplasmic streaming) needs more of ATP molecules which exist in the companion cells, this is proved later by experiments which show that the transportation process delays with the decrease of temperature or oxygen in cells thus delaying the cytoplasmic streaming

Transport in animals.

Human transport system.

Transport in Humans is a process that takes place through 2 closely related systems:

I. Blood vascular system. (Circulatory system)

II. Lymphatic system.

I. The circulatory system:

It consists of the heart and the blood vessels through which the blood passes. These vessels form a complete circuit. (A closed circulatory system)

1. The heart:

The heart is a hollow muscular organ which lies in the middle of the chest cavity. It is enclosed in the pericardium that protects the heart and facilitates its pumping action.

The heart is divided into four chambers:

The 2 atria (auricles): The upper two chambers with thin walls. Those receive blood from veins.

The 2 ventricles: The lower two chambers with thick muscular walls. Those pump blood through arteries.
The heart is divided longitudinally into two sides by means of muscular walls. Each atrium is connected to its own ventricle through an opening which is guarded by means of a valve. Each valve consists of thin flaps. In order for these flaps not to turn inside out, the free edges of these flaps are attached to the ventricle wall by means of tendons. Thus blood is permitted to flow only from the atrium to the ventricle not in the reverse direction. The right valve (The tricuspid valve) is made up of three flaps, while the left valve (the bicuspid valve or the mitral valve) is similar in structure and action, except it is formed up of 2 flaps. There are also semi-lunar valve at the connection of the heart with both Aorta and pulmonary artery. The heart beats regularly throughout the whole life time.



2. The blood vessels:

A. Arteries:

Arteries are wide vessels that carry blood from the heart to other organs of the body.

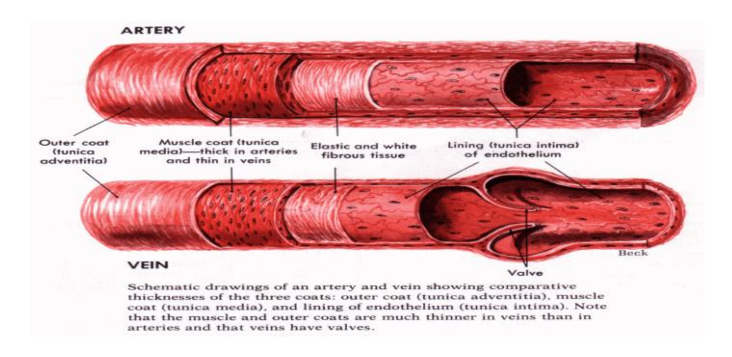
The wall of an artery is build up of three layers of tissues:

-The outer layer: A coat of connective tissue.

-The middle layer: Is relatively thick and consists of involuntary muscles which contract and relax under the control of nerve fibers.

-The inner layer: The endothelium, which consists of one row of tiny epithelial cells followed by elastic fibers that give the elasticity of the artery.

Arteries are usually buried among the body muscles. They carry oxygenated blood except the pulmonary artery which comes out of the right ventricle to the lungs (that carries deoxygenated blood.



Schematic drawings of an artery and vein showing comparative thicknesses of the three coats: outer coat (tunica adventitia), muscle coat (tunica media), and lining of endothelium (tunica intima). Note that the muscle and outer coats are much thinner in veins than in arteries and that veins have valves.

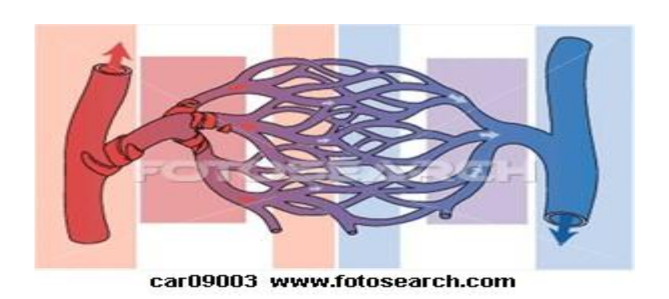
B. Veins:

Veins are the vessels that carry blood to the heart. Walls of veins are composed of the same three layers of that of arteries with the following modifications:

- There are less elastic fibers.
- The middle layer is less thick.

Accordingly, The wall of the vein is thinner than that of the artery, and it doesn't pulsate. Veins carry deoxygenated blood except the pulmonary veins that open in the left atrium (that carries oxygenated blood).
A number of veins possess a system of internal valves along their length to prevent
the backflow of blood, and allowing it to pass only in the direction of the heart. Sites of these valves can be observed in the arm veins. (when the arm is tied tightly with a bandage above the elbow). This was done by William Harvey the English doctor, who discovered the blood circulation in the 17th. Century.





C. The Capillaries:

Capillaries are tiny, microscopic vessels which connect the arterioles with the venules. This fact was discovered by Malpighi, the Italian scientist at the end of the 17^{th}. Century, thus he completed the work of Harvey.

The average diameter of capillaries ranges between 7 – 10 microns. Their walls are very thin and consist of one row of thin epithelial cells with tiny pores between them. The wall of the capillary is about 0.1 micron thick, which facilitates quick exchange of substances between the blood and the tissue cells. Capillaries spread in the spaces between cells all over the body tissues. Capillaries reach all the body cells and supply them with their requirements.

N.B

If all capillaries in the Human body were put end to end, their overall length would be about 80000 kilometres.

P.O.C	1.Artery	2. Vein	3. Capillaries
Function	1.carry blood from the hear to body organs. 2.carry oxygenated Blood except pulmonary artery which comes out of the right ventricle.	1.Carry blood from the body to the heart. 2. Carry deoxygenated blood except pulmonary veins which open into the left atrium.	1.Facilitate quick exchange of substances between the blood and The tissue cells. 2.Supply the cells with all their requirements.
position	Usually buried among the Body muscles.	Near from skin surface.	Spread in the spaces between cells all over the body tissue which connect the arterioles with the venules.
Structure of the wall	Is built up of three layer: a.The outer layer: connective tissue. b.The middle layer: relative thick, consists of involuntary muscle which contract and relax under t of nerve fibers. c.The inner layer: Endothelium consists of one Row of tiny epithelial cells Followed by elastic fibers That gives the elasticity of The artery.	The structure of the wall similar to artery but there are less elastic fibers and the middle layer is less thick, so the wall of vein is thinner than that artery	-Are tiny, microscopic vessels, their walls are very thin from 7 to 10 microns diameter. -Consists of one row of thin epithelial with tiny pores. -No muscular layer so the wall of the capillary is about 0.1 micron thick
The ability of pulsate	Have high elastic fibers, so The artery can be pulsate.	Have less elastic fibers and the middle layer is less thick , so the vein does not pulsate.	Have no elastic fibers, so the capillary does not pulsate.
The presence of valve	Have no valve	Have a system of internal valves, only allow passage of blood to the heart and prevent the back flow.	Have no valve.

3. Blood:

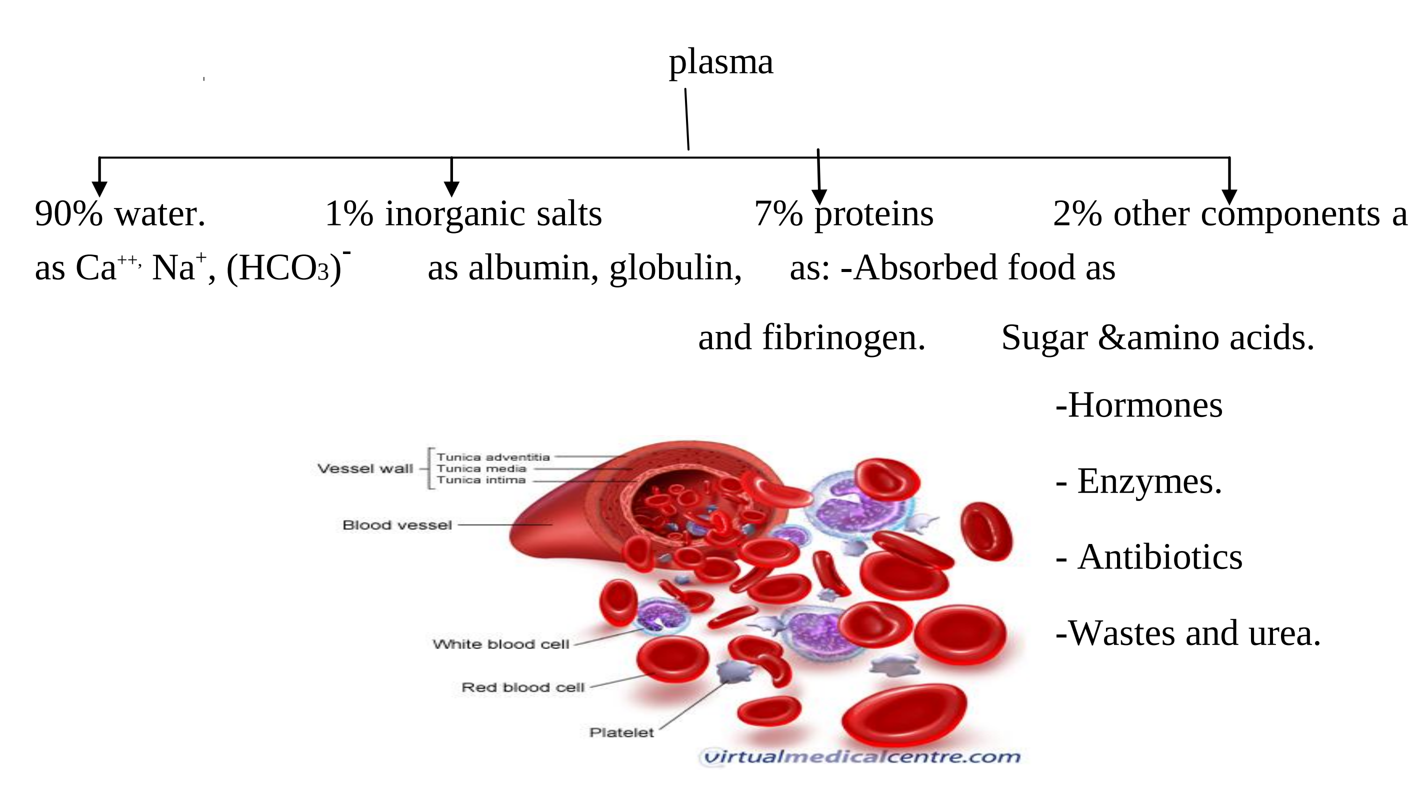
Blood is a liquid tissue. It contains red blood cells, white blood cells, and blood platelets. The fluid part of this liquid tissue is the blood plasma. Blood is the principal medium in the process of transport. It is a viscous red liquid. Blood is weakly alkaline. (PH = 7.4). The Human body contains 5 to 6 liters of blood in average.



Components of blood:

a. Plasma:

Plasma is about 54% of blood volume. It contains:



b. Red blood cells (Erythrocytes) (R.B.Cs)

Red blood cells are the most abundant blood cells. They are about:

- 4 up to 5 million cells/mm3 in males.

- 4 up to 4.5 million cells/mm3 in females.

Each is destroyed after 120 days. They circulate about 172000 circulations.

They are produced in bone marrow of backbones. They are round in shape, biconcave and enucleated. They contain hemoglobin (Protein + Iron), which gives the blood its red colour.

Inside the two lungs the hemoglobin combines with Oxygen to form pale red Oxyhemoglobin that carries Oxygen to different parts of the body, where it leaves Oxygen and unites with Carbon dioxide to form dark red Carboxyhemoglobin. So the venous blood is darker than the arterial blood.
Red blood cells are destroyed in the liver, the spleen, and bone marrow. The proteins in the hemoglobin are used in the formation of bile



c. White blood cells (Leucocytes) (W.B.Cs):

They are about 7000 cells/mm^3 and increase during diseases. They are colorless and nucleated. They live for 13 up to 20 days and continuously formed in the bone marrow, spleen, and lymphatic system. There are different types of leucocytes, each with a specific function. The main function of W.B.Cs is the protection of the body against the infectious diseases. They circulate continuously in the blood vessels, attack foreign particles, destroy and engulf them. Some of them produce antibodies.

d. Blood platelets:

They are very small in size (one-fourth of the R.B.Cs), enucleated, and live for about 10 days. They are about 250000 cells/mm^3 . They are produced in bone marrow. They play a role in blood clotting.

Functions of blood:

1. Transport the digested food substances, together with Oxygen, Carbon dioxide, waste nitrogenous compounds, hormones, and some active and inactive enzymes.

2. Control the processes of metabolism and keep the body temperature at 37 degree C. In addition, it regulates the internal environment (homeostasis) such as osmotic potential.

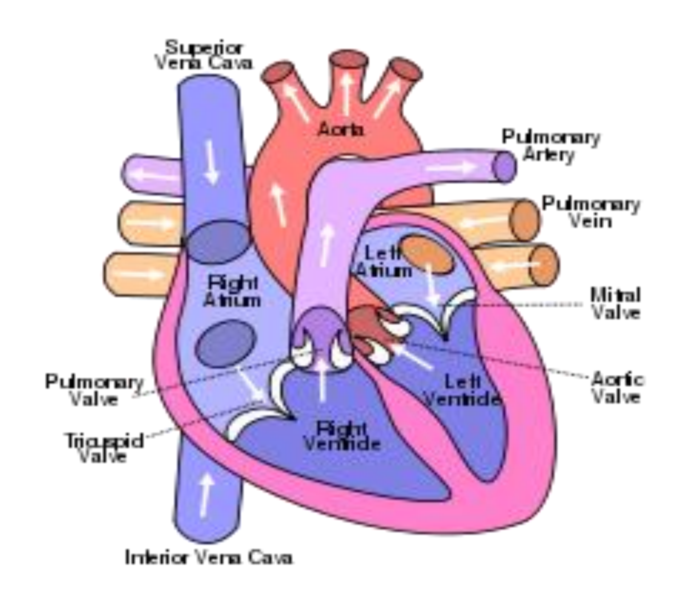
3. Protect the body against microbes and pathogenic organisms through immunity involving the lymphatic system.

4. Protect the blood itself against bleeding by formation of the blood clotting.

Heart beats:

The rhythmic heart beats are spontaneous as they originate from the cardiac tissue itself. It has been proven that the heart continues beating regularly even after it has been disconnected from the body and the cardiac nerves.





So, what is the source of the regular rhythm of heart beats?

There is a specialized bundle of thin cardiac muscular fibers buried in the right atrial wall near the connection between the right auricle and the large veins. This bundle is called **the sino-atrial node** which is considered as the pace maker of the heart. The sino-atrial node sends impulses over the two atria which are stimulated to contract. When the electrical impulses reach the atrio-ventricular node (at the junction between atria and ventricles) the impulses will spread rapidly through special fibers from the inter-ventricular septum to the walls of both ventricles, where their muscles are stimulated to contract.

The sino-atrial node (the pace maker) beats at a regular rate of **70 beats/minute**. It is connected to two nerves: one lowers down its rate (the vagus nerve), and the other accelerates it (the sympathetic nerve), so that the number of cardiac beats changes according to the physical and psychological state of the body.

For example, the number of heart beats is lowered during sleep, and gradually increases after waking up. It is also lowered in states of grief and increases in states of joy. It also increases with sever physical effort.

We can distinguish two sounds in the heart beat, one

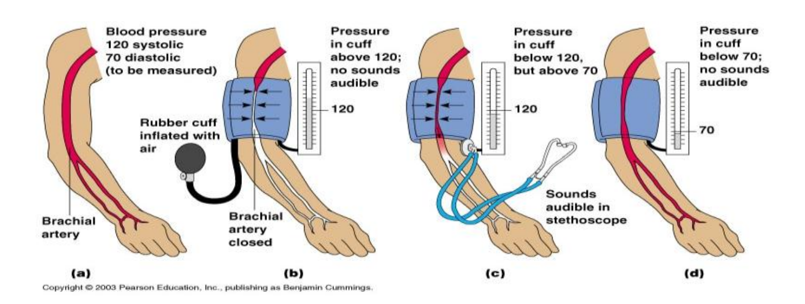
1- **long and low-pitched (lubb)**, and is due to closure of the two valves between the atria and the ventricles during ventricular contraction.
2- The other is **shorter and high-pitched (dupp)** and is due to the closure of the aortic and pulmonary valves during ventricular relaxation.



Blood pressure:

Blood is a viscous liquid. It circulates within the arteries and veins smoothly by the process of heart beats. But to pass within the microscopic blood capillaries it needs pressure.

The largest blood pressure is measured in the arteries nearer to the heart. The maximum blood pressure is measured as the ventricles contract and the minimum as the ventricles relax. The blood pressure is measured by means of mercuric instruments, **sphygmomanometers**. Its reading consists of two numbers, for example 120/80 mm Hg, which is the normal value at youth. The two measurements represent the blood pressure as the ventricles contract and relax respectively. Measurements of blood pressure at other various points along the arteries show progressive decrease. Blood pressure in the venules is very low (about 10 mm Hg). The very low blood pressure in the veins is not sufficient to move blood back to the heart. When the skeletal muscles near the veins contract, they put pressure on the collapsible wall of the vein and the blood contained in these vessels. Veins, however, have valves that prevent backward flow, and therefore pressure from muscle contraction is sufficient to move blood through veins towards the heart. The blood pressure increases gradually by aging and it must be under medical control to avoid its harmful effects. The values of blood pressure are determined by listening to the heart beats. As the ventricles contract, the doctor can listen to the heart beat, while as the ventricles relax
the sound disappears. The blood pressure can be measured when the heart beats also between one beat and another. There are some digital instruments to measure the blood pressure, but they are not accurate as mercury instruments.



Blood Circulation

There are 3 pathways for blood during its circulation:

1. Pulmonary Circulation:

It starts from the right ventricle and ends at the left atrium. When the right ventricle contracts, the tricuspid valve closes the opening of the right atrium. The deoxygenated blood will therefore rushes through the pulmonary artery through the three-flapped semi-lunar valve. This valve prevents the backflow of blood to the ventricle (when it relaxes).

The pulmonary artery gives rise to two branches, each branch goes to a lung, where it branches to form several arterioles which terminate in blood capillaries. Blood capillaries spread around the alveoli, where exchange of gases takes place. Carbon dioxide and water vapor will diffuse from the blood and Oxygen will move towards it, so that blood becomes oxygenated.

Oxygenated blood returns from the lungs through the 4 pulmonary veins (two veins from each lung) to open into the left atrium.

When the left atrium contracts, blood passes to the left ventricle through the bicuspid valve.

Right ventricle (deoxygenated blood) → semi-lunar valve → pulmonary artery → Lungs (gas exchange) → pulmonary vein(oxygenated blood) → left atrium.

2-Systematic Circulation:

It starts from the left ventricle and ends at the right atrium. When the left ventricle contracts after being filled with oxygenated blood, the mitral valve closes. As a result, blood under great pressure rushes from the left ventricle to the Aorta through an opening which is controlled by a semi-lunar valve to prevent the backflow of blood. The Aorta gives rise to several arteries, some of which move upwards while others go downwards. Arteries then branch to form smaller and smaller arterioles which end by blood capillaries. These capillaries spread through the tissues in between the cells transporting Oxygen, water, and dissolved food substances to them. On the other hand, products of catabolism such as Carbon dioxide resulting from oxidation of sugar and fat diffuse through the walls of blood capillaries and reach the blood which changes in color from right red to dark red, and is now called deoxygenated blood.

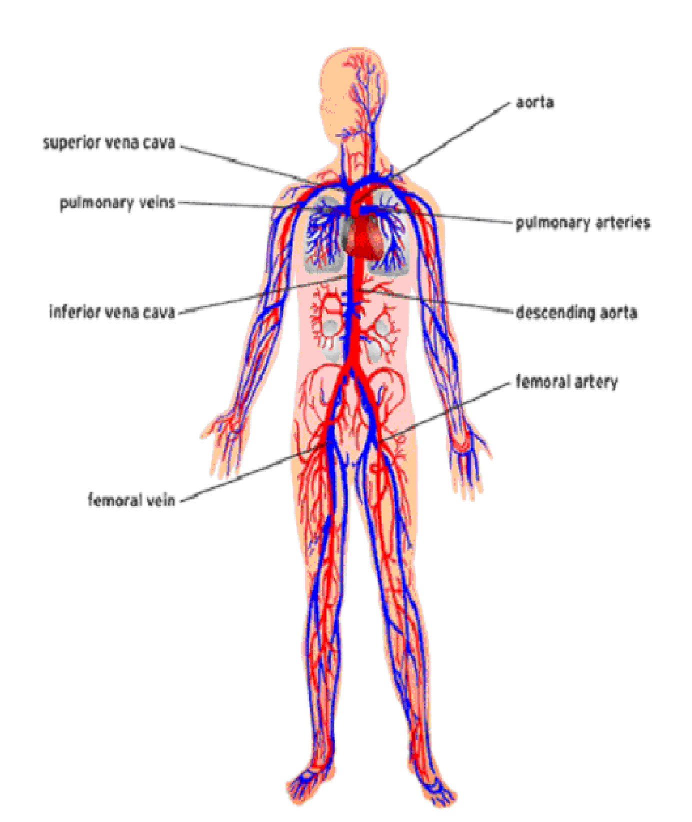


Blood capillaries collect to give rise to larger and larger venules and finally veins, which pour the deoxygenated blood into the superior and the inferior vena cava which carry blood to the right atrium.

<u>When it is filled with blood, the walls of the right atrium contracts and so blood is forced to the right ventricle which become filled with deoxygenated blood</u>. It worth noting that contraction of the right side of the heart occurs at the same time of contraction of the left side. Therefore, pumping of the deoxygenated blood from the right ventricle, and pumping of the oxygenated blood from the left ventricle, both take place at the same time.

Left ventricle(oxygenated blood) → semi-lunar valve → aorta → arteries → blood capillaries in all body parts(gas exchange) → venules (deoxygenated blood) → superior and inferior vena cava → right atrium

3. Hepatic Portal Circulation:

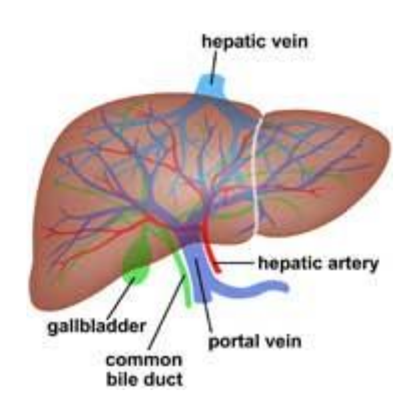


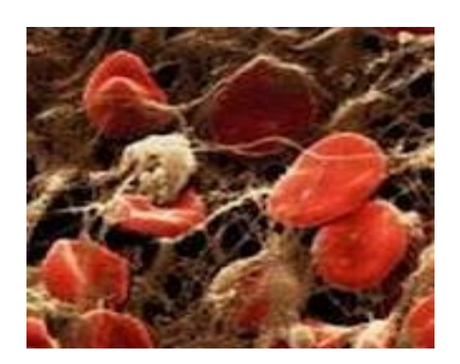


After being absorbed by the villi of the small intestines, both glucose and amino acids are transported to the blood capillaries inside

these villi. These blood capillaries aggregate into small venules, then large venules and finally they pour the contents into the hepatic portal vein. This also receives veins from the pancreas, the spleen, and the stomach.

When it first enters the liver, the hepatic portal vein branches into venules which end with minute blood capillaries. Excess food substances which exceed the body needs, filter through the capillary walls cells and passes to the liver where they undergo certain changes. Finally, blood capillaries unite into the hepatic vein, which leaves the liver to pour its contents into the upper part of the inferior vena cava just before it enters the right atrium.





Blood Clot:

When a blood vessel is cut, blood soon forms a clot to prevent bleeding before it lead to death.

-The mechanism of blood clotting:

It is initiated by a blood vessel cut and involved a sequence of steps:

1. When blood becomes exposed to air or to friction with a rough surface such as damaged vessels and cells, the blood platelets form together with the destroyed cells, a protein substance called thromboplastin.
2. In presence of Calcium ions (Ca^{++}) and blood clotting factors in the plasma, thromboplastin activates the conversion of prothrombin to active thrombin (prothrombin formation occurs in the liver with the help of vitamin K and is passed directly into the blood).
3. Thrombin, being an active enzyme catalyzes the conversion of fibrinogen (soluble protein in plasma) into an insoluble protein which is fibrin.



4. Fibrin precipitates as a network of microscopic interlacing fibers. The blood cells aggregate into this forming a clot which blocks the hole in the damaged blood vessels. In this way, bleeding stops.

Why doesn't blood clot inside blood vessels?

Blood never clots inside blood vessels as long as:
*It runs in a normal fashion, and does not slow down.
*Blood platelets should also slide easily and smoothly inside the blood vessels in order not to broken.
*Prevention of clotting inside blood vessels is, also due to the presence of heparin (secreted from the liver) which prevents the conversion of prothrombin into thrombin.

The mechanism of blood clotting is illustrated by the following simplified representation:

1. Blood platelets + Destroyed cells $\xrightarrow{\text{Factors of blood clotting}}$ Thromboplastin

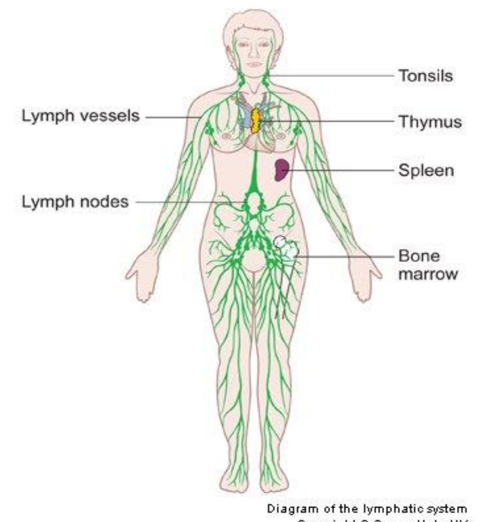
2. Prothrombin $\xrightarrow[\text{Factors of blood clotting / Ca++}]{\text{Thromboplastin}}$ Thrombin

3. Fibrinogen $\xrightarrow{\text{Thrombin}}$ Fibrin

II. The Lymphatic System

The lymphatic system is considered as the immune system of the body due to its ability for defense and the production of the antibodies that give the body its immunity.

The lymphatic system consists of large number of lymphatic capillaries. They take up blood fluid that comes out from the blood capillaries. This fluid is called the lymph. The lymph contains nearly most of the plasma constituents and leucocytes. The lymphatic capillaries empty the lymph into the circulatory system along the superior vena cava.
The lymph passes across the lymph nodes which are found at certain points along the lymph capillaries. Lymphocytes are packed into the space of lymph nodes which trap microbes by white blood cells which they produce. The spleen is considered one of the most important lymphatic organs in the body.





Chapter(2) question

Transport in plants.

Complete:-

1- Water reaches to the top of high trees by .... , ... and ....

2-Transport of water from roots to leaves by ....,...........,...............,........... And ....

3-........................... the centre of the stem.

4-......................... transfer Oxygen gas and Carbon dioxide from the lungs.

5-......................... considered as pacemaker of the heart.

6-Tracheids exist in .... and its function is ....

7-The back flow stops in veins by.........................

8-proteins represents ....% of blood plasma.

9-The number of white blood cells is a bout .... Cell/mm^3

10- .... is from plasma proteins which has a role in blood clotting.

11-Pulmonary circulation starts from ....

12-Blood that reach the brain leaves the heart from ....

G.R.F:-

1-Doctor can know if the person suffers from any inflammation by blood analysis.

....
....

2-Circulatory system of human is from the closed one.

....
....

3-The number of heart beats changes according to the psychological and physical state.

....
....

4-Heart beats have two different sounds.

....
....

5-Blood doesn't clot inside the human body.

....
....



6-Blood pressure is measured by two numbers.

....

....

7-Algae don't need specialized transportation tissues.

....

....

8-Cabium is located between xylem and phloem.

....

....

9-Deoxygenated blood is pumped at the same time with deoxygenated blood.

....

....

10-Presence of lymphatic nodes on certain distances a long the lymphatic system.

....

....

<u>What is the function for the followings:-</u>

1- Starch sheath.

....

....

2- Pericycle.

....

....

3-Haemoglobin.

....

....

4-Pericardium.

....

....

5-Atrio ventricle node.



Chapter (3)

Breathing out

Breathing in

Respiration in living organisms

https://youtu.be/hc1YtXc_84A

Chapter (3)

Respiration in Living Organisms

The concept of respiration and its importance to living organisms.

Green plants absorb energy from sun light, and change it into chemical energy during photosynthesis. They store the chemical energy in high-energy compounds, the most important of which are carbohydrates, especially glucose. Respiration process comprises the uptake of Oxygen and the release of CO2. In case of unicellulars, Oxygen diffuses directly into the cell, and CO2 passes out as a bi-product. In case of multicellulars, the presence of a respiratory system is essential. Uptake of Oxygen and release of CO2 is called gaseous exchange, which is completely different from cellular respiration.

The cellular respiration:

Cellular respiration is the process by which energy is extracted from bonds of food molecules manufactured by plants or eaten by animals. The released energy is used in generating ATP molecules.

The importance of glucose in cellular respiration:

Carbohydrates, especially glucose is considered as a form of stored energy that can be transferred from one cell to another and from one living organism to another.

The glucose molecule is considered as an excellent example to study the steps of breaking down the food molecules, as it is the molecule commonly used by the majority of living organisms to produce energy more than any molecule of available food.

Role played by ATP (Adenosine tri-phosphate) molecules:

Any energy required by a cell, needs ATP molecules. ATP molecule is considered as the small currency of energy. It can be easily spent and exchanged, it can be considered as the universal currency of energy in the cell.



The structure of ATP molecules:

ATP molecule is built up of 3 subunits:

1. Adenine: Which is a nitrogenous base (has the properties of a base)

2. Ribose: This is a 5-Carbon sugar (a pentose)

3. Three phosphate groups: Those are linked together by two high energy bonds.

During cellular reactions, only one of these bonds usually break down, only one phosphate group is removed by hydrolysis of an ATP molecule, which becomes ADP **(Adenosine di-** phosphate), and an amount of energy (which is about 7-12 K Cal/mole) is released.

Adenosine tri-phosphate ⟶ Adenosine di-phosphate + A Phosphate group + Energy (7-12 K Cal/mole)

Steps of cellular respiration:

(The complete oxidation of a glucose molecule):

The process of cellular respiration starts with a glucose molecule, and can be summarized in the following equation:

$$C_6H_{12}O_6 \xrightarrow{\text{Respiratory enzymes}} 6\ CO_2 + 6\ H_2O + 38\ ATP$$

Cellular respiration takes place in three major stages:

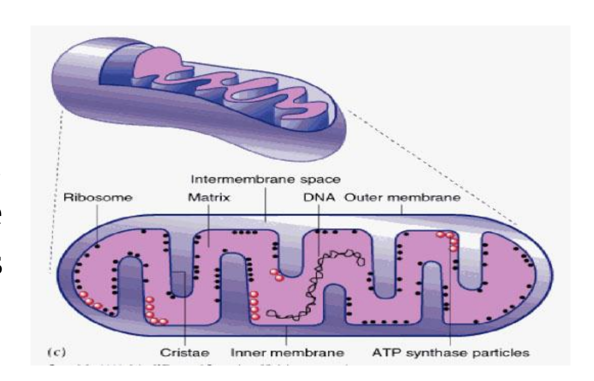
1. Glycolysis:

That takes place in the non organ part of the cytoplasm (cytosole) of the cell.

2. Krebs cycle

3. Electron transport

Those take place both inside the mitochondria, where respiratory enzymes, water, phosphate groups, co-enzymes, and electron-carrier molecules (cytochromes) exist.





Hydrogen Carriers:

During Glycolysis (break down of glucose), and Krebs cycle, Hydrogen atoms are removed from the Carbon skeleton of the glucose molecule that pass to co-enzymes (NAD+ and FAD) which act as Hydrogen carriers:

$$NAD^+ + H_2 \xrightarrow{\text{Reduction}} NADH + H^+$$

$$FAD + H_2 \xrightarrow{\text{Reduction}} FADH_2$$

1. Glycolysis:

Glycolysis takes place in both aerobic and anaerobic respiration to produce energy. In glycolysis one molecule of glucose breaks down forming two molecules of pyruvic acid (3-carbon), two molecules of ATP, and two molecules of NADH + H^+ passing through a group of reactions through which glucose is converted into:

1. Glucose 6-phosphate (6-carbon)

2. Fructose 6-phosphate (6-carbon)

3. Fructose 1-6-diphosphate (6-carbon)

4. Two molecules of PGAL (phosphoglyceraldehyde) (3-carbon)

5. Two molecules of pyruvic acid (3-carbon).

So, the oxidation of the glucose molecule into 2 pyruvic acid molecules is accompanied with:

-The reduction of 2 molecules of NAD^+ into 2 molecules NADH + H^+

-The production of 2 molecules of ATP in the cytosole of the cell.



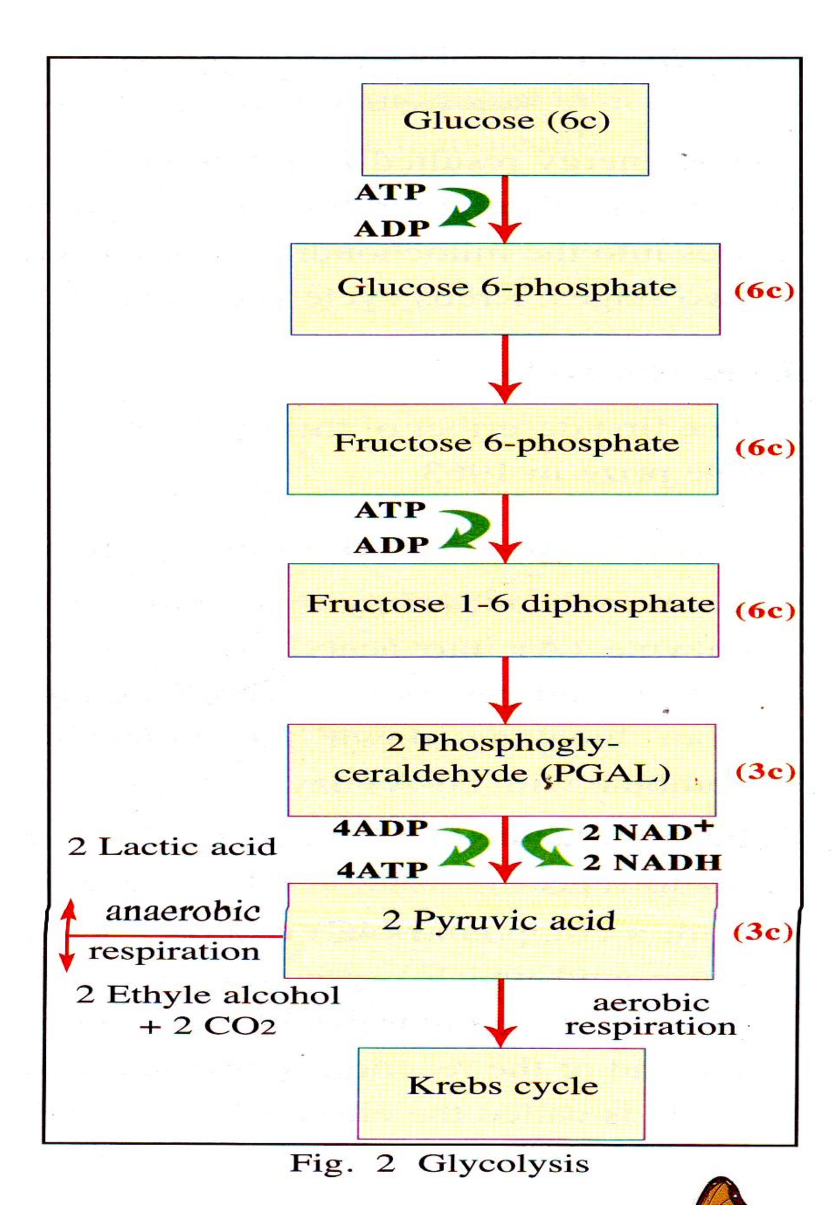


Fig. 2 Glycolysis

NAD+ : Nicotine amide adenine di-nucleotide.

FAD : Flavin adenine di-nucleotide.

All these reactions occur in the absence of Oxygen, so they are called anaerobic respiration. The energy resulted is not enough to perform all the vital activities of living organisms. Therefore, in the presence of Oxygen, pyruvic acid molecules pass into the mitochondria to produce more energy. This takes place in two consecutive stages: Krebs cycle, and electron transport.



Anaerobic respiration

$$C_6H_{12}O_6 \xrightarrow[\text{Respiratory enzymes}]{\text{Anaerobic respiration}} 2C_3H_6O_3 + 2ATP$$

2. Krebs cycle:

Krebs cycle takes place in two stages:

Stage 1:

Each molecule of the two pyruvic acid molecules (3-carbon) is oxidized in the presence of Co-enzyme-A into acetyl Co-A (2-carbon) that join Krebs cycle. In this reaction:

- Two molecules of $NADH + H^+$ are produced.

- Two molecules of CO_2 are produced.

$$\underset{\text{(3-carbon)}}{\text{2 Pyruvic acid}} + \text{2 Co-A} \xrightarrow{2NAD^+ \rightarrow 2NADH + H^+} \underset{\text{(2-carbon)}}{\text{2 Acetyl Co-A}} + 2\,CO_2$$

N.B: Acetyl groups from breaking down fat molecules or protein molecules can combine with Co-A to join Krebs cycle.

Stage 2:

Each molecule of Acetyl Co-A joins Krebs cycle where its Co-A splits off to repeat its role. At the same time, Acetyl group (2-carbon) combines with Oxaloacetic acid (4-carbon) to form Citric acid (6-carbon):

Acetyl Co-A (2-carbon) + Oxaloacetic acid (4-carbon) ⟶ Citric acid (6-carbon) + Co-A

Citric acid passes through three intermediate compounds to form Oxaloacetic acid once more. These compounds are:

- Ketoglutaric acid (5-carbon)
- Succinic acid (4-carbon)
- Malic acid (4-carbon)

Krebs cycle is also called Citric acid cycle, because Citric acid (6-carbon) is the first compound formed during this cycle due to the combination of Acetyl Co-A (2-carbon) with Oxaloacetic acid (4-carbon) to form Citric acid (6-carbon).

Oxidation during Krebs cycle doesn't need Oxygen, since all electrons and protons are removed from the carbon skeleton during oxidation of carbon atoms and received by NAD^+ and FAD that are reduced into $NADH + H^+$ and $FADH_2$

In the pathway of Krebs cycle:

- **2 molecules of CO2 are released.**
- **1 molecule of ATP is produced.**
- **3 molecules of $NADH + H^+$ are produced.**
- **1 molecule of $FADH_2$ are produced.**

Krebs cycle is repeated twice for each glucose molecule.



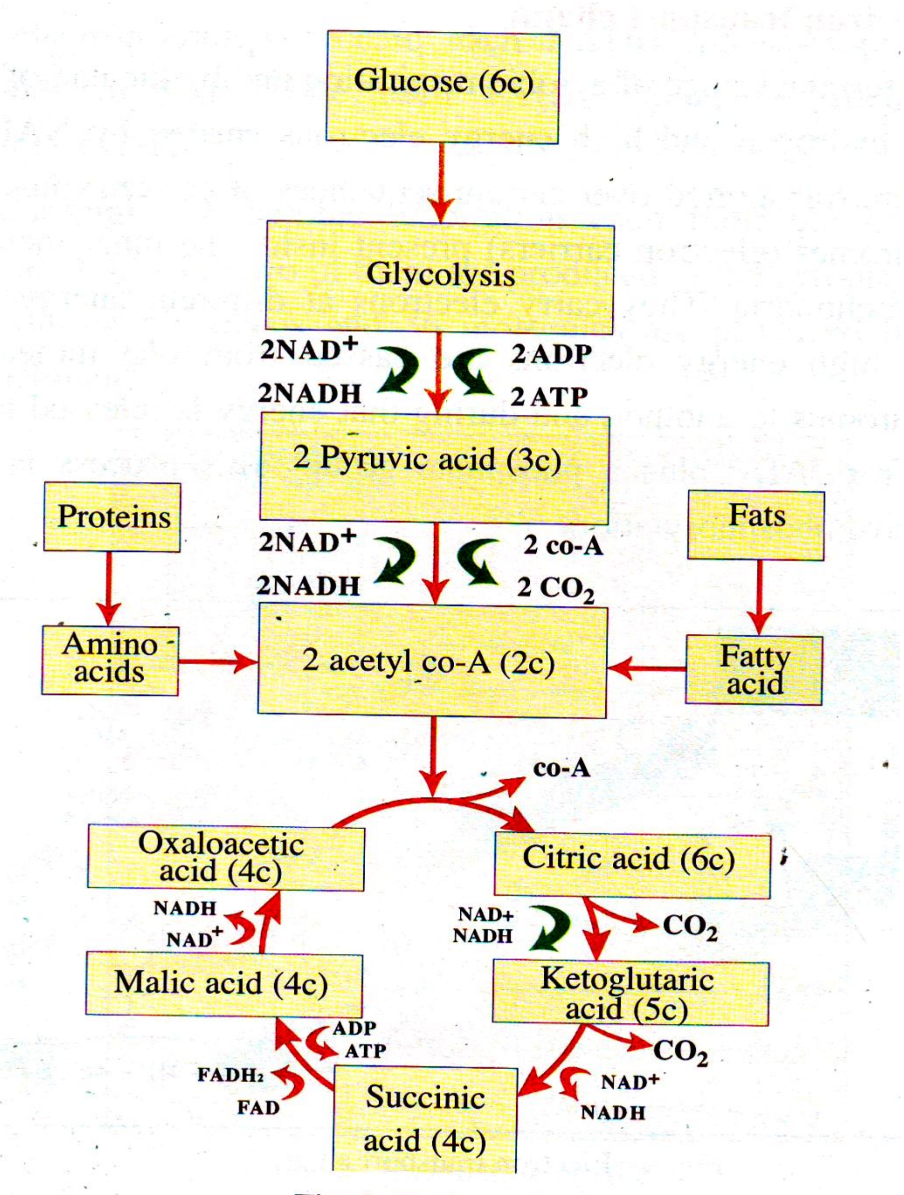


Fig. 3 Krebs cycle

3. Electron transport chain:

At the end of Krebs cycle, Hydrogen with high-energy electrons carried by NADH + H^+ and FADH2 are transported by a sequence of Co-enzymes called cytochromes (electron carriers) present at the inner membrane of the mitochondria. These cytochromes carry electrons at different energy levels. These high-energy electrons are passed from one cytochrome to another, and at the same time they descend from higher energy levels to lower ones. During this, energy is released to form ATP from ADP + A phosphate group. This process is called Oxidative phosphorylation:

ADP + P + Energy ⟶ ATP

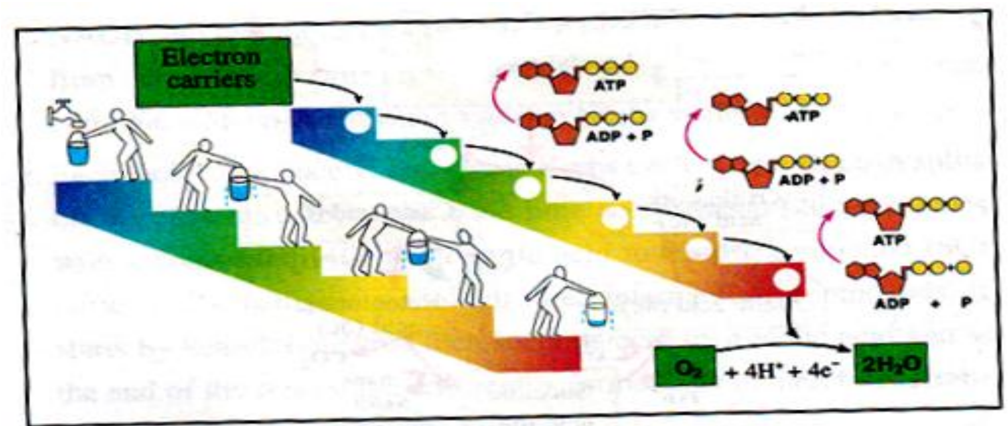


Fig. 4 Electron transport chain

-Oxygen is considered the last receptor of hydrogen in the electron transport chain, where the two electrons combine with the two protons and one Oxygen atom to form a water molecule. As follows:

$$2\,e^- + 2\,H^+ + \frac{1}{2}\,O_2 \longrightarrow H_2O$$

In the electron transport chain:

Each NADH + H^+ molecule releases energy enough to form 3 ATP molecules. While each $FADH_2$ molecule releases energy enough to form 2 ATP.

Accordingly, during aerobic respiration, each molecule of glucose produces 38 ATP molecules, two of which are produced in the cytoplasm of the cell during glycolysis, and 36 ATP molecules are produced inside the mitochondria (the respiratory stage).

Anaerobic respiration:

When Oxygen is missing or in low quantity, living organisms as Bacteria and Fungi respire by anaerobic respiration. Some plant and animal cells may also respire anaerobically when Oxygen is not available. This is also called fermentation, and it doesn't need Oxygen, but it takes place in the presence of some special enzymes.
Anaerobic respiration begins with the same beginning of the aerobic respiration.
The Glucose molecule is decomposed into two molecules of pyruvic acid, with the formation of two molecules of NADH + H^+ and a small quantity of energy (2 ATP molecules)
Pyruvic acid is converted according to the type of the cell in which it was formed:



- In case of animal cells, especially muscle fibers, when the muscles exert vigorous efforts or exercises, they consume most of the oxygen in their cells and tended to convert Pyruvic acid into Lactic acid after its reduction by combining with Hydrogen on NADH + H^+

This is known as Muscular Fatigue. If Oxygen is available, Lactic acid is converted into Pyruvic acid again and then into Acetyl Co-A.

- In case of Bacteria, Pyruvic acid converts into Lactic acid.

$$C_6H_{12}O_6 \xrightarrow{\text{Acidic Fermentation}} 2C_3H_6O_3 + 2ATP$$

- In case of Yeast fungus, or in some plant cells, Pyruvic acid is reduced into Ethyl alcohol and Carbon dioxide. This process is called Alcoholic Fermentation and is used in the industry of some products.

$$C_6H_{12}O_6 \xrightarrow{\text{Alcoholic Fermentation}} 2C_2H_5OH + 2CO_2 + 2ATP$$

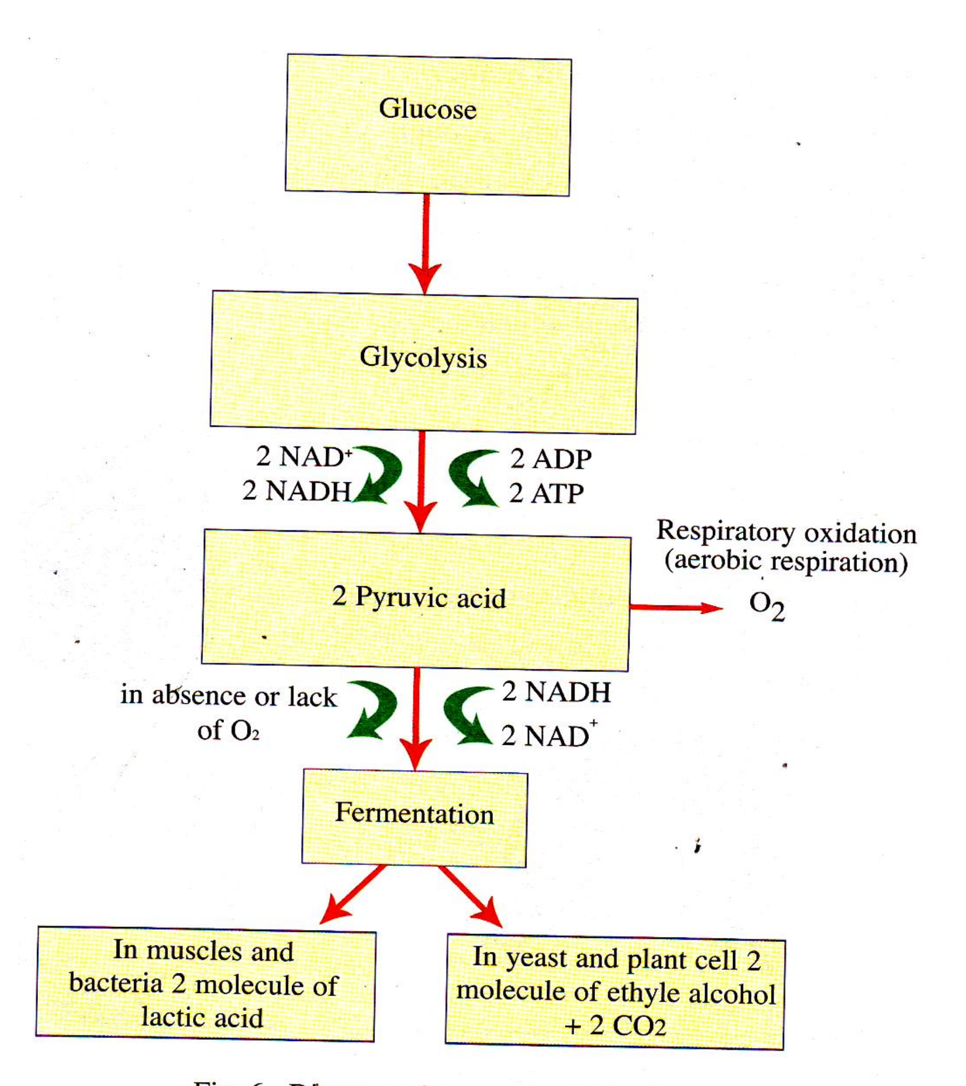
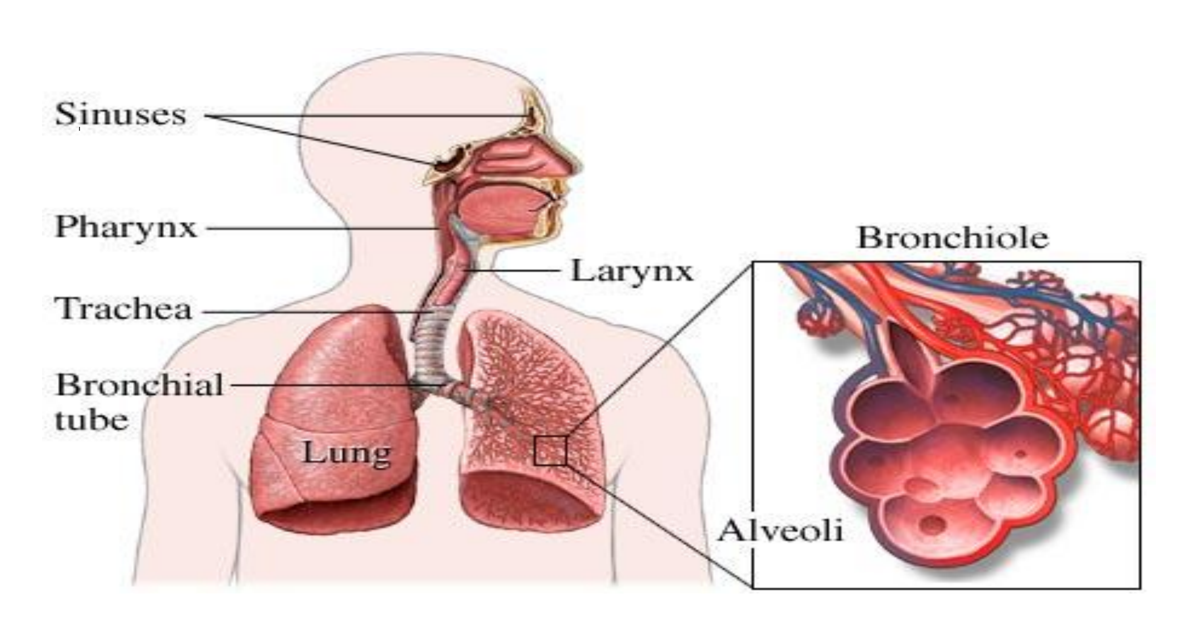


Fig. 6 Diagram of anaerobic respiration

The Respiratory System in Man



1. An air entrance:

Air enters the body through the nose or the mouth. It's preferable for air to enter through the nose because:

a. This passage is warm, as it is lined with numerous blood capillaries.

b. This passage is moist, as it secretes mucous.

c. This passage serves as a filter, as it contains hairs that act as a filter.

2. The Pharynx:

Pharynx is a common passage for both air and food.

3. The Larynx:

Larynx is also known as the voice box.

4. The Trachea:

Air enters the trachea through the larynx. The trachea wall contains a series of cartilage ¾ rings which prevent the trachea wall from collapsing, thus maintaining an open passageway for air.
The inner surface of the trachea is lined with cilia which beat upwards to create air and mucous currents; this impedes the entry of small foreign bodies and moves them to



the pharynx, where they may be swallowed. The trachea is divided at its lower end into two bronchi.

5. The two bronchi:

Each bronchus enters a lung, where it divides and sub-divides into progressively smaller and smaller bronchioles. Each bronchiole finally opens into one of the many alveoli (air sacs), of which there are about 600 millions per lung.

N.B.: 1

. The thin alveolar walls are considered the actual respiratory surface, as they are surrounded with a large network of blood capillaries. Blood receives Oxygen from
the alveolar air and carries it to the rest of the body. It gives out CO2 to the alveoli in return, so that it may get rid of it.

N.B.: 2.

The whole group of alveoli, and bronchioles connected to them, together with the huge network of capillaries, constitute the lung. Each animal, and also Man possesses two lungs, a right lung, and a left lung.

Respiration in Plants.

The green plant absorbs light energy from the Sun and transforms it into chemical energy through photosynthesis process to store as high energy complex organic molecules (glucose). Whenever the plant needs energy to carry out one of its vital activities, it releases this energy slowly in a chain of reactions which includes breaking down of carbon bonds of the organic substances. This is the process of respiration in plants. If Oxygen is present, aerobic respiration occurs, but if Oxygen is absent it is called anaerobic respiration.



Gaseous exchange:

1. In most plants:

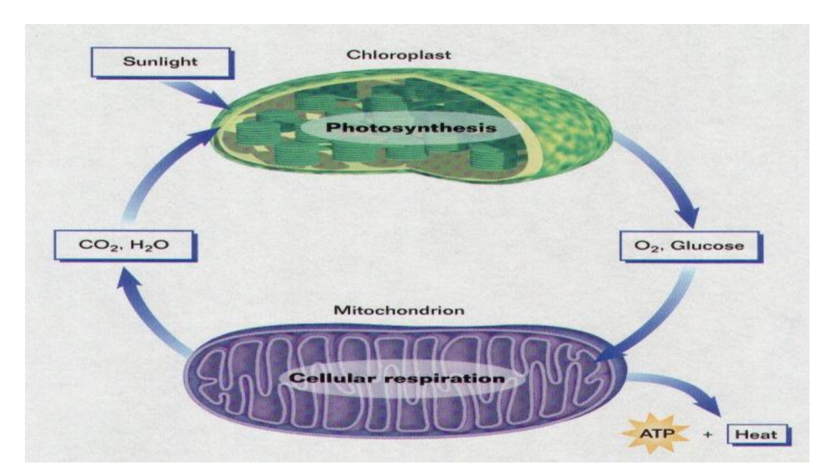
Each living cell is in direct contact with the external environment and therefore gaseous exchange is easy. Oxygen gas diffuses inside, while Carbon dioxide is released outside the cell.

2. In vascular plants:

That are complicated in structure, Oxygen reaches the cells through various passage ways:

a. Through the stomata of leaves, when they open, air enters to the air chambers and then diffuses through the intercellular spaces spreading to various parts of the plant. Oxygen then diffuses through the cell membranes and dissolves in the water of the cell. Some of the Oxygen is carried to the phloem passage way, dissolved in water, and finally reaches the tissues of the stem and the root.

b. Oxygen may enter the plant through the roots, soluble in water of the soil solution when it is absorbed by the root hairs, of imbibed by the cell walls.



c. Through the stomata that spread on the surface of the stems of some plants (with green stems)

d. Through the lenticels or any cracks in the bark of woody stems.

N.B.: Carbon dioxide resulting from respiration of the plant is expelled to the external environment by direct diffusion from plant cells that are directly exposed to the external environment. While in case of deep-seated cells, gaseous exchange occurs by mutual diffusion of CO_2 in return to xylem and vessels or phloem tissue which passes CO_2 in return to stomata, then to the external atmosphere.

The relation between photosynthesis and respiration in plants:

The following figure represents the cycle of cellular respiration and photosynthesis. Study it and create your own comparison between the two processes.



Experiments on Respiration

Experiment 1:

To illustrate the evolution of CO_2 gas during aerobic respiration:

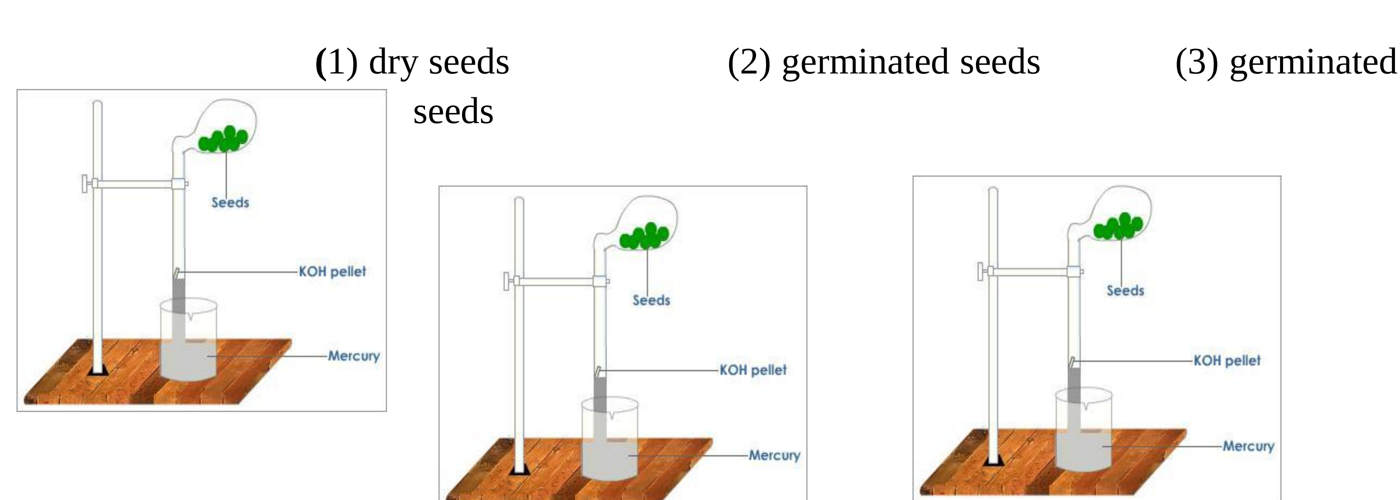
A. In non-green parts of the plant (seeds):

1. Put some Potassium hydroxide solution (KOH) in a beaker. Insert some dry seeds (peas) in a glass retort, and dip the end of the retort stem in the Potassium hydroxide solution in the beaker. (apparatus no. 1)

2. Put some Sodium chloride solution (NaCl) in a beaker. Insert some soaked seeds in another retort, and dip the end of the retort stem in the Sodium chloride solution in that beaker. (apparatus no. 2)

3. Put another quantity of Potassium hydroxide solution (KOH) in a third beaker. Insert some soaked seeds in a third glass retort, and dip the stem of that retort in the Potassium hydroxide solution in that third beaker. (apparatus no. 3)

4. Leave the three retorts for some time.



(1) dry seeds (2) germinated seeds (3) germinated seeds

Observation:

No change occurs in apparatus 1 and 2.

In case of retort 3: Potassium hydroxide solution rises up in the stem of the retort.



Interpretation:

In case of apparatus 1:

Dry seeds do not respire actively, therefore no change occurs under these conditions.

In case of apparatus 2:

Seeds soaked in water need to germinate and grow, therefore they must respire actively to obtain energy. They absorb Oxygen from the surrounding air, and they release an equal volume of CO_2. So, no change is observed in the volume of the air inside the retort. This is because the released CO_2 is not absorbed by Sodium chloride solution. So, the components of the air inside the retort have changed, but the total volume remains constant.

In case of apparatus 3:

The germinating seeds are actively respiring. CO2 gas is released in a volume equal to that of the absorbed Oxygen. The released CO2 will be absorbed by Potassium hydroxide solution. So, the solution rises up the stem of the retort.
This proves that CO2 gas is produced as a result of respiration in non-green parts of the plant (seeds).

By comparing the 3 cases, it is clear that:

1. Dry seeds do not respire actively. So, the volume and the components of air remains without change.
2. Germinating seeds respire actively, and the volume of air remains constant during respiration because the released CO2 is equal in volume to the absorbed Oxygen.
3. When germinating seeds (which are non green parts of the plant) respire, they release Carbon dioxide gas.

B. Green parts of the plant:

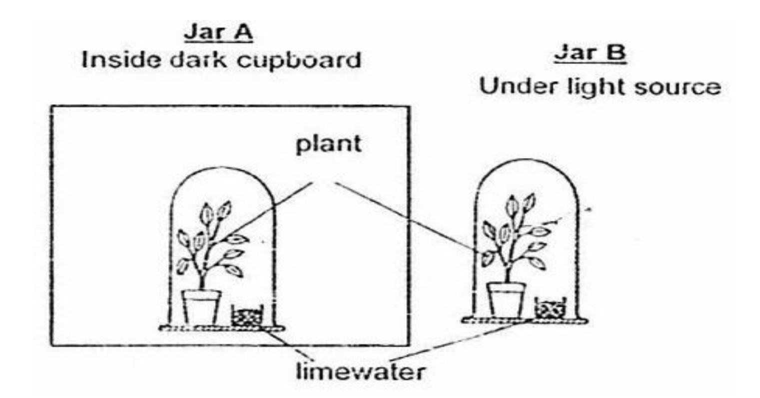
1. Take a green potted plant, and place it on a glass plate together with a small beaker containing clear lime water. Invert a glass bell-jar over the two. Then cover the jar with a black piece of cloth.

2. Prepare a similar apparatus, with a pot empty of any cultivated plant.

3. Put some clear lime water in a small beaker, and leave it exposed to the atmospheric air.

4. Leave the 3 apparatus for some time.





Observation:

Lime water becomes turbid in (1) only.

Interpretation:

In (1), the green plant in the pot has respired and produced CO_2 gas, which causes the turbidity of lime water in the beaker. The bell-jar was covered with a black piece of cloth in order to keep light away from the plant and to stop the process of photosynthesis (which uses up CO_2 inside the bell-jar which has been released due to respiration).

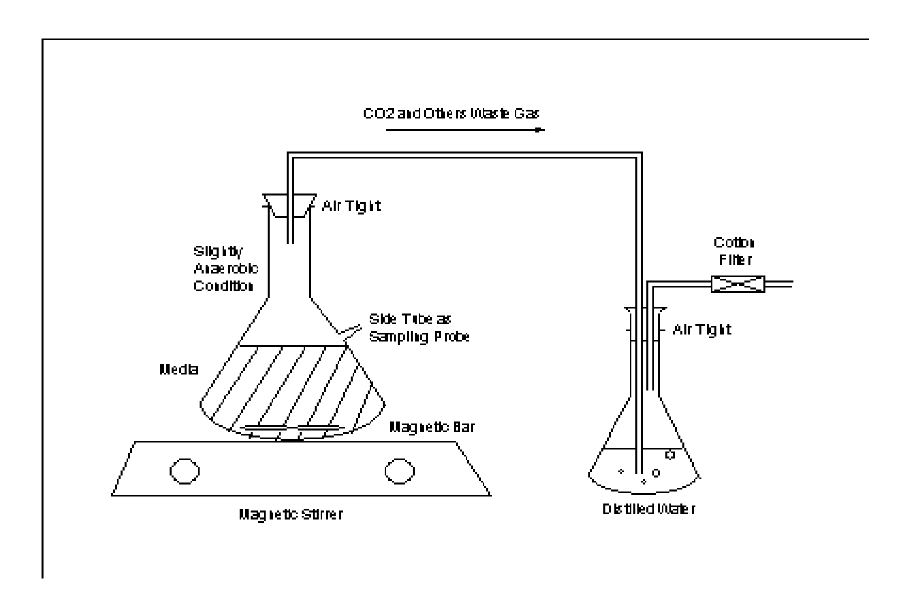
In (2) and (3), the lime water shows no turbidity due to the small percentage of CO_2 whether in the air of the bell-jar or in the atmospheric air.

Experiment 2:

To illustrate the process of alcoholic fermentation:

1. Put a sugary solution (or molasses diluted with double of its volume with water) in a conical flask. Add a piece of Yeast and mix it thoroughly.
2. Close the flask with a stopper of rubber through which a delivery tube passes.
3. Dip the free end of the tube into a beaker containing lime water.
4. Leave the apparatus in a warm place for several hours.





Observation:

1. Gas bubbles are seen on the surface of the solution in the flask.

2. Lime water has become turbid.

Conclusion:

Turbidity of lime water is a proof that CO2 gas has been evolved, as a result of the anaerobic respiration of yeast.

N.B.:

There is another kind of fermentation called acid fermentation carried out by several kinds of bacteria. It produces an acid instead of alcohol. Many milk products such as cheese, butter, and yoghurt are manufactured by this kind of fermentation.

Seeds of Angiosperms too, have the power to respire anaerobically, if they are kept under anaerobic conditions.



Chapter (3) question

Write the scientific terms:-

1-The process by which Oxygen enters directly into the living organism from the surrounding air and release CO_2 (....................).

2-A compound produced from breaking down of glucose ,proteins and lipids and enter in Krebs cycle.(................)

3-The process in which pyruvic acid is converted to ethyl alcohol and CO_2 in yeast.

(....................................).

4-Along tube contains a series of cartilage rings that maintain it open. (.......................)

5-Structures in woody plant stems provide an entrance of air for respiration.(...................)

Complete the followings:-

1-In cellular aerobic respiration Oxidation of glucose occurs through ....

2-Krebs cycle is started by combing acetyl group with fourth carbon compound to form ....

3- .... ATP are produced from Oxidation of two molecules of glucose in aerobic respiration inside mitochondria.

4-Electron transport chain allows the electron to release ....

5-Electron transport chain is described as sequence of ....

6-Pyruvic acid is oxidized to form ....

7- CO_2 is released as a result of ....

Give Reason For:-

1-Krebs cycle doesn't need Oxygen.

....

....

2-The cellular respiration differs from burning process.

....

....

3-Formation of intermediate compounds in Krebs cycle.

....

....

4-38 molecules of ATP are produce from the complete oxidation of glucose.

………
………

5-Diffusion of Oxygen from alveoli to the blood.

………
………

6-Photosynthesis is linked by respiration in plant.

………
………

Illustrate by a complete labeled diagrams the followings:-

1-Mitochondria.

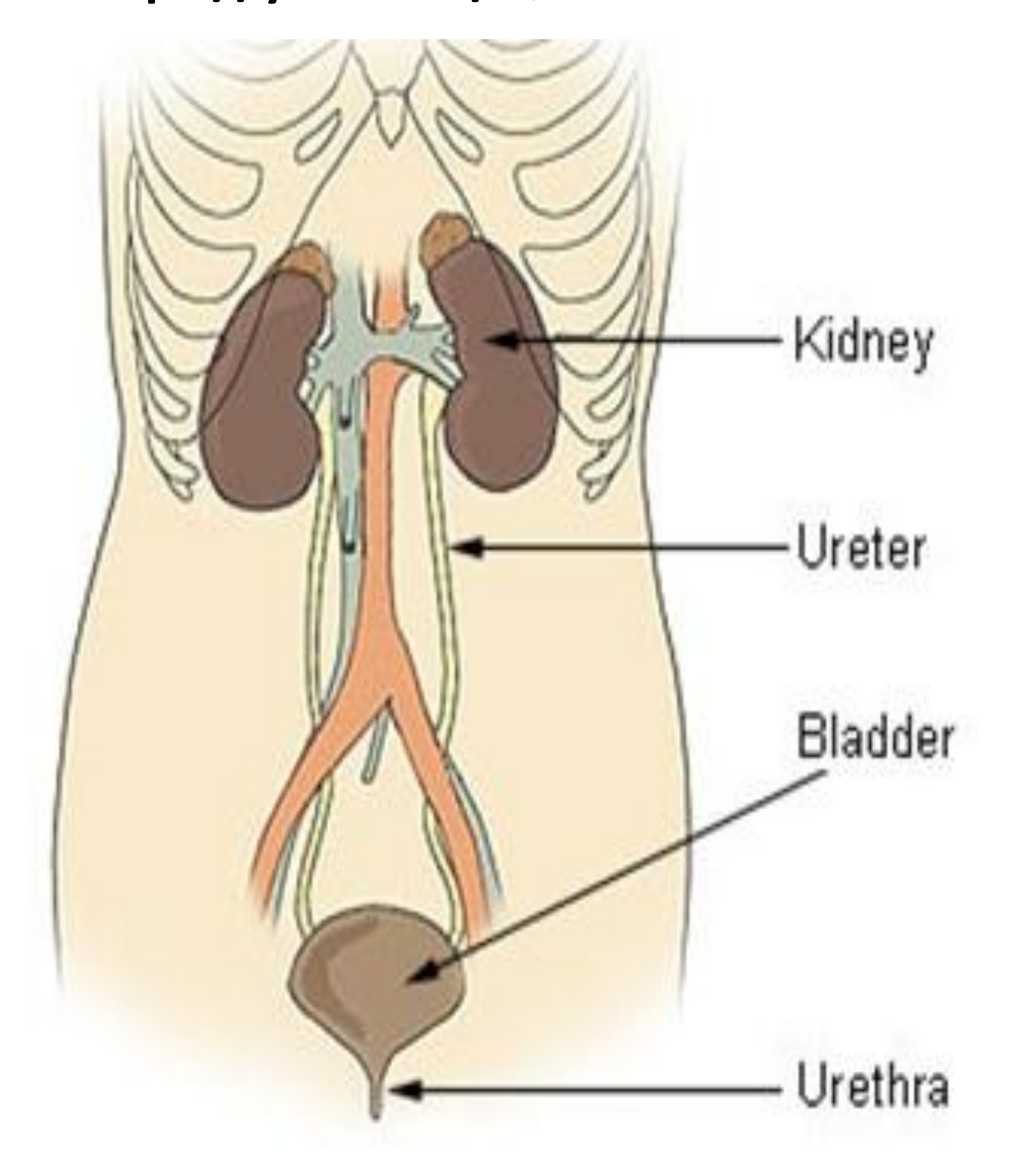
………
………
………
………
………
………
………
………

2-Chloroplatid.

………
………
………
………
………
………
………
………
………
………

Chapter (4)

https://youtu.be/QsSdAXv5BEM



Excretion in Living Organisms

Concept and importance of excretion.

All biological processes that occur in the bodies of all living organisms are carried out through chemical reactions that leave some waste products. The living organism must get rid of these waste products as soon as they are formed, otherwise it will cause many problems and infections.

Excretion: the process by which the living organisms get rid of these waste products.

Excretion in Animals.

Excretion refers to the materials that leave the body through the plasma membranes.

Note:

The undigested food that goes out of the animal body in the form of faeces is not considered as excretion.

The Nitrogen in the air which enters the lungs in inspiration and leaves them in expiration is not considered as excretion.

The important waste products that are produced and excreted from the animal's body:

1. CO_2 and water: that are produced and excreted from organic molecules degeneration.

2. The nitrogenous waste products (Ammonia, Urea, and Uric acid) that are resulted due to protein degradation.



N.B.:

1. The organs that carry out excretion in higher animals are the skin, the lungs, the liver, and the kidneys.
2. Organs of excretion also regulate the body contents of minerals.
3. Some of the spices that have volatile content leave the body through the lungs, and the rest is excreted through the kidneys.
4. The poisonous materials are transformed into non-poisonous forms in the body or into non-soluble form by the liver or the kidneys.

The following table represents the important waste products of the Human body, and the ways of their excretion:

The excreted material	The excretion organ
Carbon dioxide	Lungs
Water	Kidneys / Skin / Lungs
Nitrogenous waste products	Kidneys / Skin (small percentage)
Salts	Kidneys / Skin
Spices	Kidneys / Lungs (volatile substances)

Excretion in Man

The skin:

The skin is considered an excretory organ in Man. It's the biggest organ in the body, as it covers the whole body and the limbs from the outside.

Skin structure:

It consists of two main layers: an outer epidermis and an inner dermis, under which there is a layer of fat.



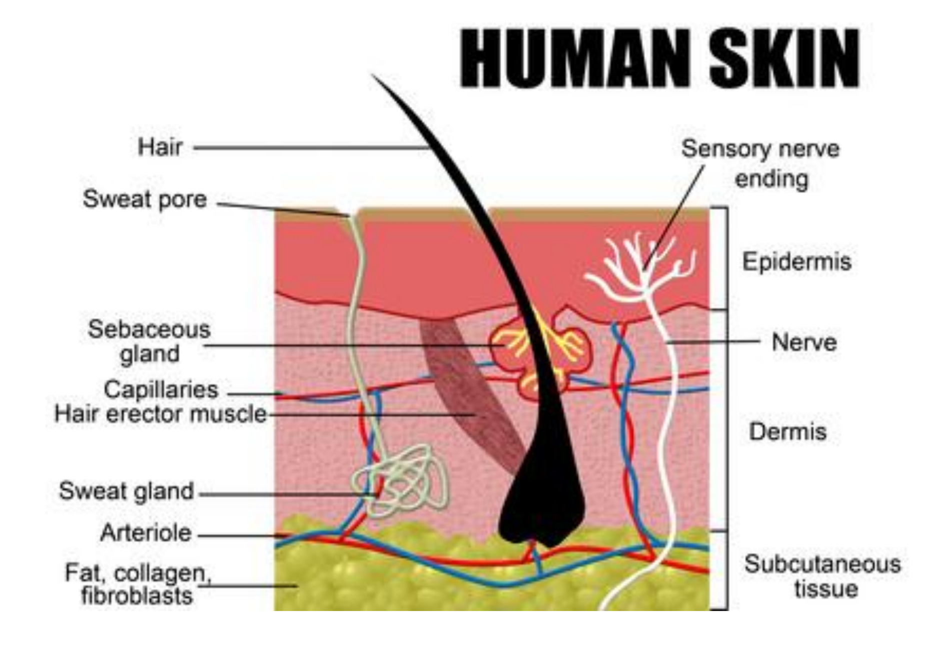
1. The epidermis:

It consists of several layers of epithelial cells.

- ✓ **At the surface: These cells are dead, full of a horny substance called keratin, and always are subjected to friction, e.g. when wiping your face or body with a towel, or rubbing your hands. This layer is worn away and is continuously replaced from beneath.**
- ✓ **At the base of its inner layer: There are pigment cells which secrete granules responsible for the color of the skin (melanin).**

2. The dermis:

It lies next to the epidermis, consisting of connective tissues. Dermis contains blood capillaries, nerve endings, lymphatics, sweat glands, fat glands, fatty cells, and hair follicles. There are sensory nerve endings that respond to touch, pain, and temperature.



The sweat gland:

Is a coiled tube that reaches the skin surface through a pore.

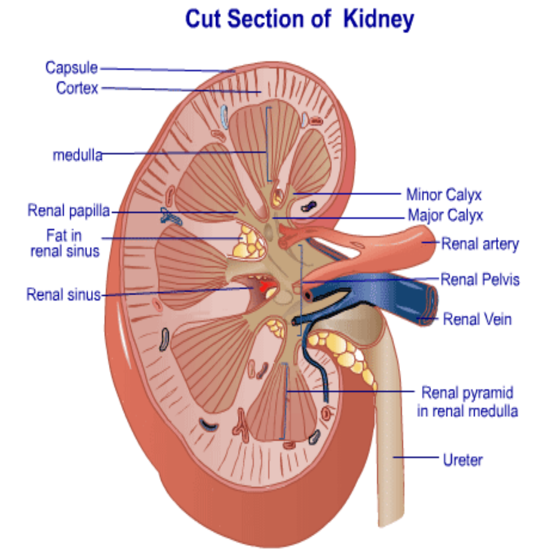
Sweat is continually being produced on the surface of the skin, so decreasing the body temperature through its evaporation. Remaining wastes cause the skin to be sticky. It is important to remove these wastes continually by washing; otherwise sweat pores become blocked resulting in a foul odor.

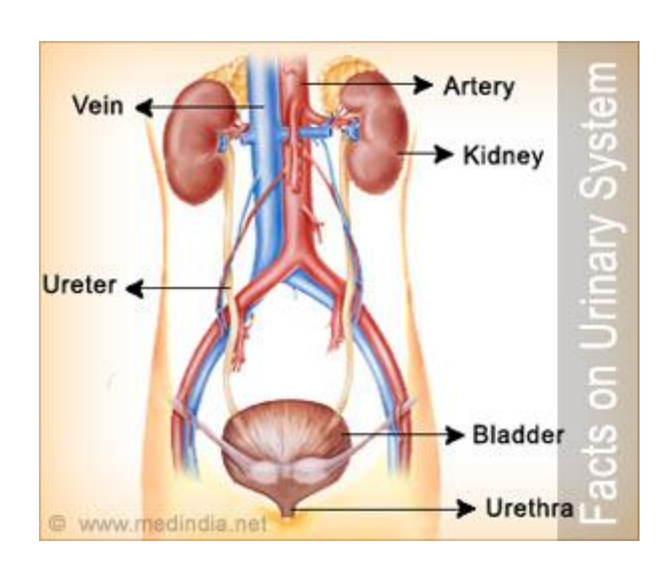
The hair:

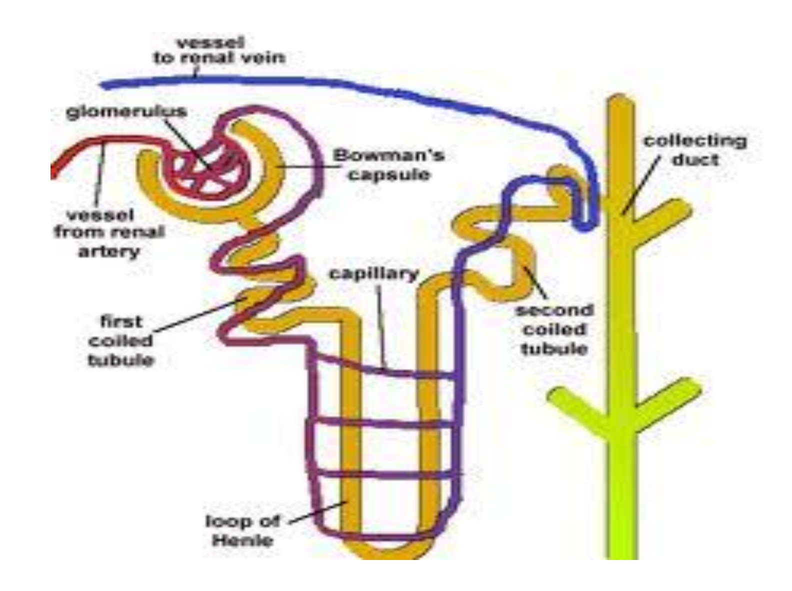
The hair is made of a hair follicle, surrounded by many blood capillaries. At its free end, there is a sebaceous (fat) gland, which produces an oily secretion that facilitates the exit of the hair from the skin, keeping it soft and pliable. The hair follicle is supplied with an erector muscle.

The kidney:

Each vertebrate animal has two kidneys. In lower vertebrates, the kidneys are long, thin organs which extend from the two sides of the vertebral column. In higher vertebrates, such as mammals, the kidneys are more firm and are situated behind the peritoneum (membranes lining the abdominal cavity).The ureter emerges from each kidney, which passes the urine into the urinary bladder.. A sphincter muscle closes the outlet of the bladder till urine accumulates, then the bladder contracts expelling the urine through a duct called the urethra.







Structure of the nephron

Kidney structure:

The two kidneys are situated in the upper part of the abdominal cavity, one at each side of the vertebral column. The length of each kidney is about 12 cm long, and about 7 cm wide. Its thickness is about 3 cm. The kidney is bean-shaped. Its outer part is convex, while the inner one is concave. On the inner side of each kidney, the renal artery comes from the Aorta, and the renal vein leads to the posterior (inferior) vena cava. Internally, the kidney is differentiated into two regions,

1. **an outer narrow cortex**
2. **an inner broad medulla.**
   - ✓ **The functional unit of the kidney is the nephron, of which there are about one million in each kidney.**

The structure of the nephron:

The nephron starts in the cortex with a cup-shaped, thin, double-walled Bowman's capsule. The capsule leads to the first coiled tubule in the cortex, then to the loop of Henle in the medulla which is U-shaped, then to the second coiled tubule in the cortex before joining the collecting duct. This duct opens in the concave cavity of the kidney which is called the pelvis.

Urine extraction:

The renal arteries come from the Aorta, each entering a kidney at its concave surface. The renal artery divides into a great many arterioles and capillaries at the cup-shaped nephron. Plasma (blood fluid) filters out of the blood to collect in the nephron. The filtered fluid contains: water, wastes, salts, and glucose. Blood cells and large protein molecules remain in the blood.

What happens if all the contents of this fluid are excreted outside the body?

The body will lose much of its required water and essential substances and the individual has to drink 170 litres of water daily to compensate its loss. Therefore, re-absorption of required water, glucose, and mineral substances back into the blood, must take place.

The remaining liquid contains nitrogenous wastes (urea), some inorganic salts and excess water which form the urine. Excess substances such as small amounts of glucose and Vitamins may be also present.

Re-absorption:

Re-absorption takes place in the nephron tubules. Urine then passes down the collecting duct to the pelvis of the kidney where it collects and continues down the ureter to the bladder to be stored. When the bladder contracts, urine is expelled through the urethra.



N.B.:

1. Kidneys, ureters, urinary bladder and urethra are collectively known as the urinary system.

2. The individual can live with one kidney. In this case, this kidney grows and becomes slightly bigger to perform the function of the two kidneys. No one can live without a kidney, nor can he live if the kidneys stop functioning. Accumulation of poisonous wastes in the blood happens leading to death.

3. The human body contains about 5.6 litres of blood. 1.2 – 1.3 litres of blood passes through the kidney per minute.

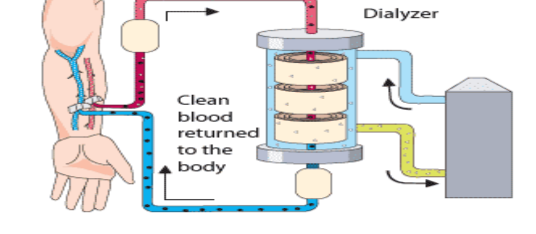
4. The total amount of blood which passes daily through the kidney is about 1600 litres (i.e. approximately ¼ of the blood volume pumped by the heart). This means that a very high percentage of blood always passes through the kidney.

5. Of the total blood volume, three litres of plasma pass through the kidney to be examined about 560 times per day.

The artificial kidney:

Kidney failure takes place due to some diseases. The kidney stops functioning and this leads to the accumulation of harmful wastes in the blood.

In treating cases of kidney failure, a tube is inserted into an artery in the patient's arm and the blood is channeled through semi-permeable tube immersed in a bath containing all the normal blood chemicals except urea and other metabolic wastes. Since the concentration of harmful metabolic wastes is higher in the blood than in the bath, they pass through the wall of the tubes into the bath and purified blood is returned to the body. A patient receives artificial kidney treatment for several hours each day, 2 – 3 times a week.



Excretion in Plants

Excretion in plants does not cause any serious problem, since:

1. The rate of catabolism is much lower in plants than that in animals of the same weight, so accumulation of metabolic wastes in the plant cells will be very slow.

2. Green plants re-use the catabolic wastes, for example:

a. Carbon dioxide and water which result from respiration are reused in photosynthesis.

b. The nitrogenous wastes are reused in the synthesis of the required proteins.

3. Since the metabolism of plants is based mainly on carbohydrates rather than proteins, this reduces their excretory needs, as the wastes of carbohydrates metabolism are less toxic than those resulting from protein metabolism.

4. The metabolic wastes such as organic salts and acids are stored in the form of insoluble crystals in the cytoplasm, or in the vacuole. Since these crystals are insoluble they will cause no harm to the cells.

N.B.:

1. Many plants get rid of Carbon dioxide and some mineral salts through their roots.

2. Plants which live in soils rich in Calcium can get rid of the excess amounts of these elements by its accumulation in leaves which are finally shed.

3. Carbon dioxide which results from respiration and Oxygen obtained from photosynthesis are excreted through the stomata by diffusion.

4. Excess water is lost mainly through transpiration and guttation.



Guttation:

Drops of water are seen at the leaf tips of some plants as Potatoes and Tomatoes. This occurs in the early morning in spring. There is a special system for guttation which consists of one or many loose cells opening by a water stoma called a hydathode which opens constantly day and night. Guttation water contains other substances which can therefore be deposited, when water evaporates rapidly.

Guttation

Transpiration:

Water needs in plants:

1. The plant needs water more than an animal of equal weight.
2. The animal can retain water in its body to be used again, while the plant loses about 90% of its water content to the outside.
3. The plant absorbs 17 times more water daily than that taken in by a man of equal mass.
4. One feddan of Maize plant needs more than two million litres of water during its life.

In facts, great quantities of water are absorbed from the soil, mainly through the roots. Water is then transferred through the conductive tissues (Xylem) to the stem and leaves. At the same time the plant loses most of this water in a continuous manner. Loss of water in the form of water vapor from the plant is called transpiration.

Stomatal Transpiration:

Water passes, in the form of vapor, through the moist cell walls of the mesophyll tissue, and evaporates into the intercellular spaces, where it diffuses out into the atmosphere through the stomata. The same process occurs in other cells with intercellular spaces

between them in different plant tissues. More than 90% of the total water loss is lost though the stomata and is called stomatal transpiration.

Stomata occur in plant leaves rather than any other vegetative organ. So, most of the transpired water is lost through the leaves. In most dicotyledonous plants, the leaf blades are wide, flattened and contain a network of veins. The veins contain transporting elements (xylem) which provide the mesophyll with water. The mesophyll tissue is characterized by the presence of intercellular spaces, which allow water to evaporate continuously to these spaces through the cell walls.

Cuticular Transpiration:

Small quantities of water pass through the cuticle that covers the epidermis of the vegetative organs in the form of water vapor; it does not exceed 5% of the total amount of the lost water.

Lenticular transpiration:

Stems of woody plants lose small quantities of water vapor through the lenticels by lenticular transpiration. It does not exceed 5% of the total amount of the lost water.

	Guttation	Transpiration
Definition	The excretion of water drops of leaf tips of some plants.	The loss of water in the form of water vapour.
Time	Early morning in spring	All seasons and increase in sunny days
Place	Through hydathode (opened permanently)	Stomata (open and close) , cuticle or lenticles
The components of lost water	Contains some materials	Doesn't contain any materials
The amount of lost water	Little amount	Majority of lost water



Importance of transpiration for the plant:

1. The decrease of the plant temperature:

A large amount of energy absorbed by the leaves is in the form of heat or is converted into heat inside the leaf tissues. This may cause a rise in the leaf temperature, especially in sunny, warm days. This rise in temperature harms the protoplasm and could lead to its death if transpiration did not decrease the plant's temperature through water loss.

2. The ascent of water and salts from the soil:

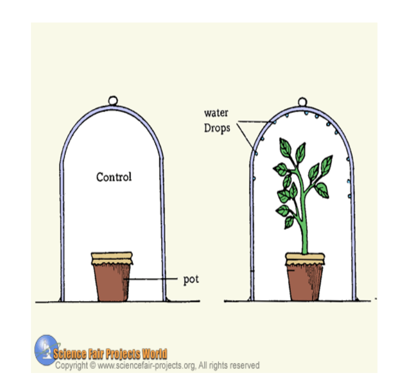
The root cells contain cell sap with a concentration (of soluble organic and inorganic substances) higher than that of the soil solution. As a result, the soil water enters the root cells by osmosis. The osmotic pressure is sufficient to move water from the root hairs to the inner root tissues till it reaches the xylem vessels and tracheids. Water rises upwards through the xylem vessels of the stem, then through vessels of leaves (in veins) and at the end it reaches the mesophyll cell sap, decreasing the ability of these cells to pull up more water.

There are intercellular spaces full of air between the mesophyll cells, to which water evaporates. As a result of the continuous loss of water `from the mesophyll cells, the concentration of salts in these cells increases, and so the ability to pull water upwards increases. This explains the so-called transpiration cycle and its role in the ascent of water.

N.B.:

Osmotic pressure is only enough to move water through the plant stem for a short distance by what is known as root pressure. In some trees, water has to move through their vessels to a height reaching up to 125 meters, and therefore, a new theory was put forward to explain the force which pushes water to such heights. This theory is known as adhesion, cohesion, and transpiration pull theory.

An experiment to illustrate transpiration in plants:



1. Take a potted leafy plant.

2. Cover the soil surface and the surface of the pot with paraffin.

3. Place the potted plant on a glass sheet under a dry bell-jar and wait for some time.

Observation:

Tiny droplets of water appear on the inside of the bell-jar that accumulate, become bigger in size and run downwards on the wall of the bell-jar.

Conclusion:

Air inside the bell-jar receives water vapor from the plant which condenses forming water that changes the white color of anhydrous copper sulfate into blue confirming that it is water. Water passes from the exposed parts of the plant to the surrounding air.

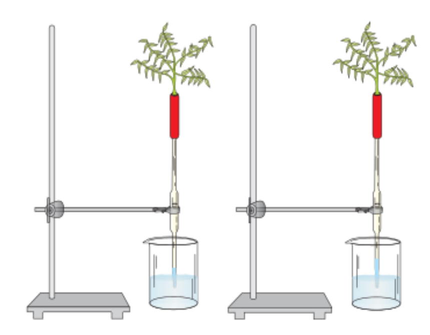
An experiment to show that water ascends through xylem:

1. Fill a test tube with eosin solution.

2. Carefully detach a small flowering plant with its roots from its soil.

3. Immerse the plant roots in the eosin solution, and close using a cotton wool plug.

4. Keep the tube in a vertical position for few hours.





Observation:

The leaf petioles change to pink, as well as the veins of the leaves and petals.

6. Cut a thin transverse section of the plant stem and examine it under the microscope (after placing it on a slide).

Observation 2:

Xylem tissue only is stained be eosin.

Conclusion:

Pink coloration of petioles and petal veins indicates that eosin solution reaches these organs. This experiment proves that:

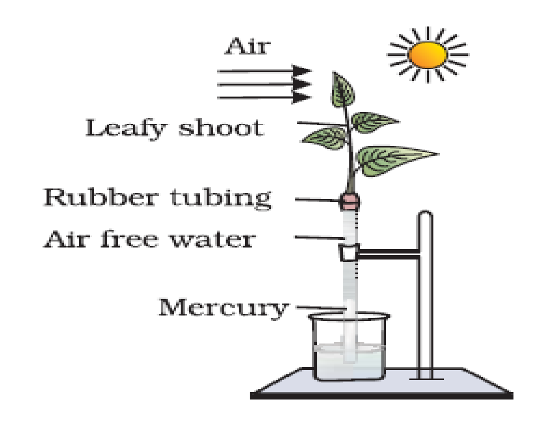
1. Water is absorbed by roots.

2. Water ascends through xylem tissue of the stem to the leaves.

An experiment to show the ascent of water by transpiration:

1. Fill a small beaker with mercury.
2. Fill a narrow tube with water and invert it in the beaker, so that its lower end becomes immersed in the mercury.
3. Cut a leafy twig of a potted plant under water and insert the lower tip of the twig in a cork plug through a hole and fix the cork plug tightly with the twig in the upper opening of the tube and close it firmly with Vaseline.
4. Mark the mercury level in the tube.
5. Leave the apparatus in open air for a while.





Observation:

Mercury rises in the tube.

Conclusion:

The rise of mercury in the tube is due to transpiration pull, where the leafy twig loses water by evaporation, so water from the tube must rise to replace it. As a result, mercury rises up in the tube. This indicates that water loss by transpiration generates a pull to raise water upwards.

Chapter (4) question

Write the scientific terms:-

1-A biological process to get rid of harmful metabolic products.(.........................).
2-Acoiled tube end with a thin tube at the surface of the skin.(.......................).
3-A functional unit in the kidney that extract the urine(Cup shape –Bowman's capsul).
(......................).
4-The concave cavity of the kidney that al nephric tubes are collected inside it.(................).
5-The excretion of water at the leaf tip of some plants at morning. (......................)
6-The opening that present in the cork layer of the tree's stem. (......................)
7-The loss of water in form of water vapour from the stomata. (......................).

Complete the followings:-

1-The volatile contents some substances as spices leave the body through ....
2-From the functions of the epidermal skin is ....
3-The urea is extracted by ....
4-The average number of the human nephrons in the each kidney is ....
5-..controls the excretion of the urine outside the body.
6-Artificial kidney depends on .... to filter the blood from the poisons.
7-The urea is extracted from ....
8-The plant excrete the excess water through .... and ....

Give Reason For:-

1-Exiting of CO_2 is considered as excretion while defecation is not.
....
....
2-The sweat gland is coiled tube.
....
....
3-The sweat also produced in winter.
....
....
4-Man can live with one kidney.
....
....
5-The container of the artificial kidney is specialized purified liquid.
....
....



6-The excretion in plant is not considered as a problem.

....

....

7-The falling of leaves of some plants is useful for excretion.

....

....

What Happens when:-

1-Absence of pigment from the skin epidermis.

....

....

2-Transporting of growing plant to a sunny plant.

....

....

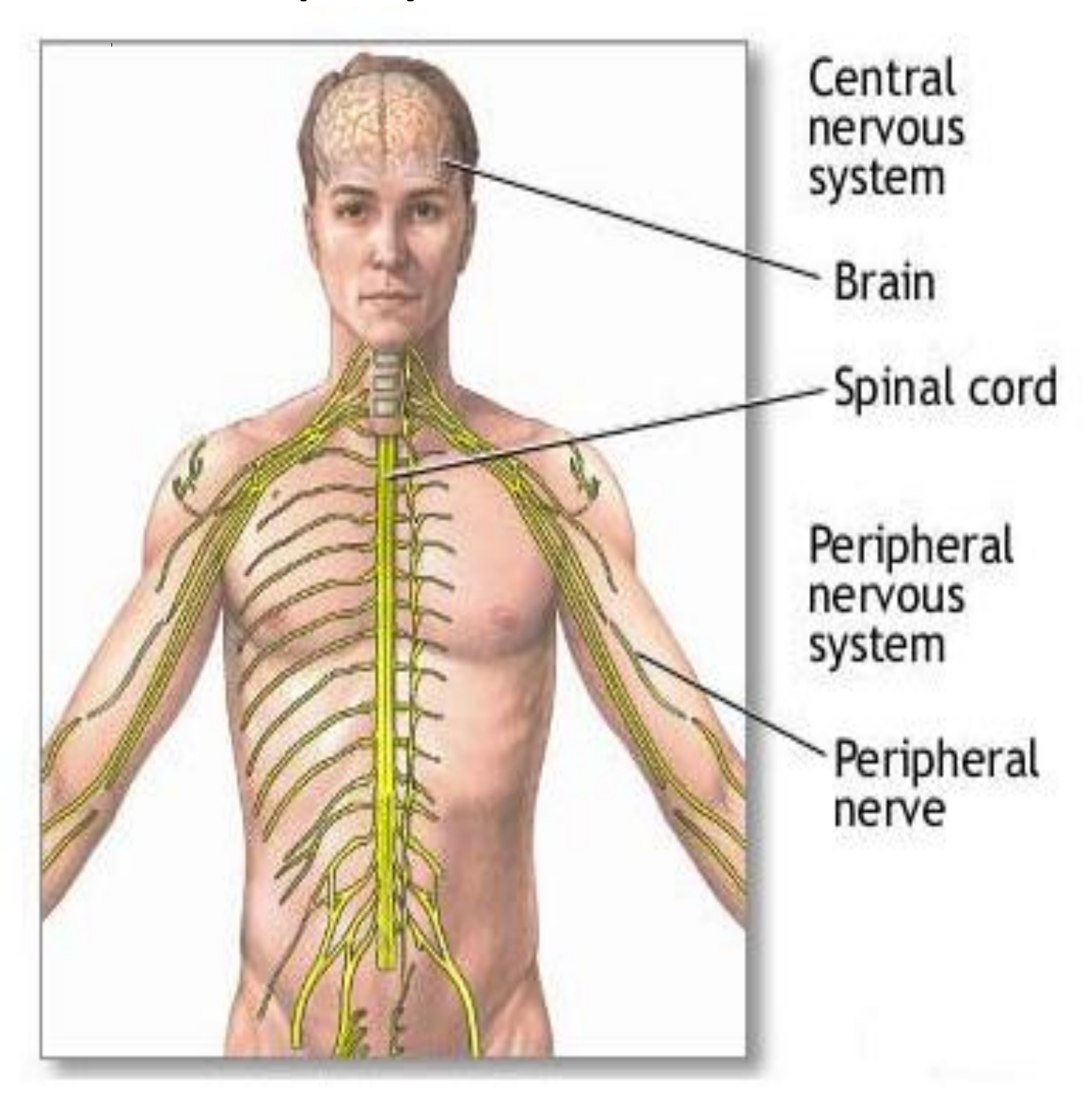
3-Exiting of all contents of blood fluid in nephron outside the body.

....

....

Chapter (5)

https://youtu.be/JHAKCGi-eeo



Sensitivity (Irritability) in Livings

Sensitivity (Irritability) in Livings

Sensitivity

-is one of the functions done by a living organism to maintain its life. Sensitivity in animals is more obvious than that in plants,

the highest efficiency is in man

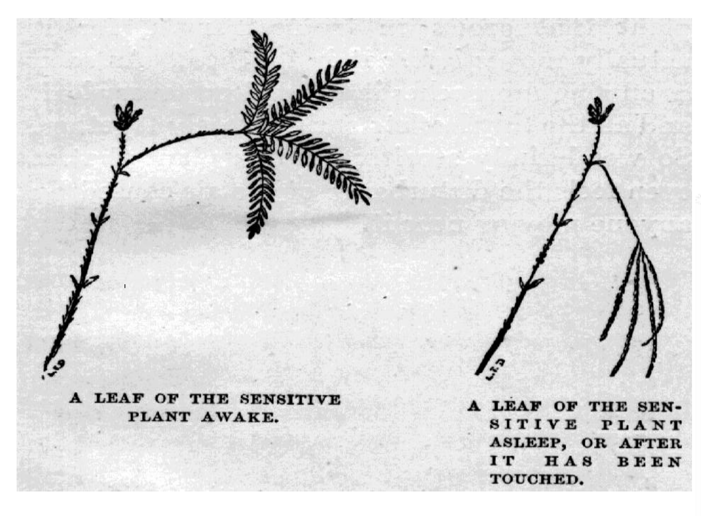
-It is the suitable response of the living organism to the internal and external stimuli to maintain its life.

Sensitivity in plants

1) Response to touch and darkness:

- ✓ If you **touch a Mimosa** leaflet, its petiole soon droops as if it has wilted. Other neighboring petioles soon follow, till the effect is seen in all leaflets.
  In the day time, the leaflets are held in a horizontal position.
- ✓ **At night**, the leaflets hang downwards and fold their upper surfaces (undergoing sleep movement)







Explanation of the movement:

These movements can be explained according to **cell turgidity**. **As Mimosa leaves are compound, and pinnate, each has a primary rachis which carries at its end four secondary rachises. Each secondary rachis carries two rows of leaflets. At the base of each primary and secondary rachis, and also at the base of each leaflets, there is a swollen structure called a pulvinus.**

When the leaflet is touched or at night, the primary rachis hangs downwards, the secondary ones become depressed and so the upper surfaces of the opposing leaflets become folded together. The pulvini act as joints in these movements, where the lower surfaces shrink when being touched, as the cell walls of the lower half of each pulvinus are more sensitive. This leads to water diffusing to the neighboring tissues and hence the leaflet drop. When the stimulus is removed, the cells regain their turgidity and the leaflets open once more.

2) Tropism:



The growth of roots and stems depends on many factors such as light, humidity, and gravity, when these factors are exerted on the sides of the stem or roots in an unequal form, curvature results. This curvature is called tropism.

Types of tropism:

A. Positive and negative phototropism:

Experiment:



1. Place a straight seedling on a cork disc floating on the surface of a beaker half-filled with water.

2. Put the beaker in a light-proof box with a circular hole at one of its sides, to admit light.

3. Leave it for few days.

Observation:

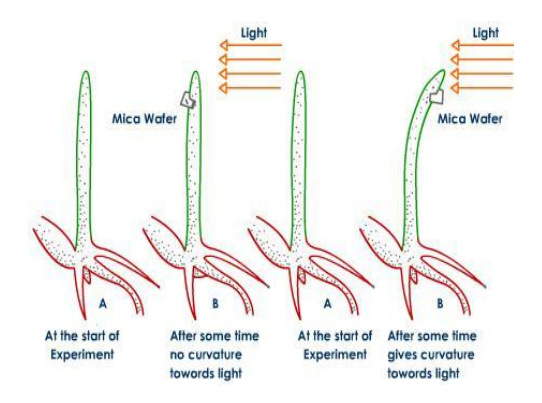
The stem inclines towards the source of light, while the roots incline away from it.

Conclusion:



Tropism is due to the unequal growth rates at the two sides in both the root and the stem. The side of the stem away from light grows more rapidly, while in case of the roots the opposite occurs.

Explanation of phototropism:



Boysen Jensen found that:

1. Oat (Avena) coleoptile lose its ability to bend towards light, **if the tip is cut off** (1-2 mm of the tip).

2. This ability is restored if the decapitated tip is returned or fixed again to the tip with gelatin.

3. If the tip is separated from the remaining coleoptile with mica sheet, there will be no curvature.

The indicates that the tip of the coleoptile synthesizes chemical substances, that diffuse through gelatin, and affect the growth. It can not pass through mica sheet. These chemicals are termed Auxins, the main one is known to be Indole-acetic acid (IAA). Curvature towards light is the result of the unequal growth of the two sides which is due to the unequal concentration of auxins on the two sides of the coleoptile.

Went experiment to prove the validity of Boysen Jensen explanation:

1. He exposed an Oat coleoptile to unidirectional illumination.

2. He cuts off the tip and placed it on two Agar blocks separated by a metallic sheet.



3. He measured the concentration of auxins in each block.

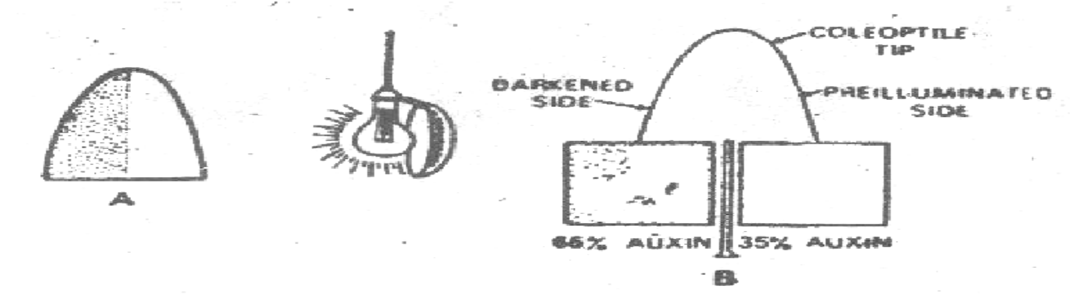


Fig: Experiments about distribution of hormone in coleoptile

Observation:

He found that a great amount of auxins accumulated in the Agar block next to the side of the tip away from light.

Conclusion:

Auxins move from the side facing light to the far (dark) side.

Went found that these blocks of Agar will produce curvature if they are placed on decapitated coleoptiles which are not subjected to light. Auxins move away from light to the non-illuminated side. This leads to elongation of cells on that side thus curvature towards light occurs. The stem is known to be **positively phototropic.**

The difference in the behaviour of the root and stem towards unidirectional illumination:

Accumulation of auxins in the dark side of the root produces an opposite effect, elongation is inhibited in the dark side, while the illuminated side continues to grow. The root curvature tends away from light, and the root is known to be negatively phototropic. The concentration of auxins required for the elongation of root cells is less than that required for the elongation of stem cells. So, the increase in auxins concentration will inhibit cell-elongation in roots, whereas it activates cell-elongation in the stem.

B. Geotropism:



Geotropism is the response of plant parts to the external stimulus of gravity, where they move away or towards the stimulus. The root grows vertically downwards, while the stem grows upwards.

It was believed that roots grow downwards in order to avoid light and seek nutrients, but this is incorrect.

Experiment:

Hang a potted plant upside for a time.

Observation:

The root grows downwards away from the soil, and towards gravity, while the shoot grows away from gravity.

Conclusion:

Growth of the root downwards is a positive response to gravity, while the growth of the stem upwards is a negative response to gravity.

Experiment:

1. Germinate a number of seeds in a soil moistened with water.

Observation:

1. **The plumules grow vertically upwards, while the radicles grow downwards.**

Experiment:

2. Place one seedling on its side so that the radicle and the plumule are horizontal.

3. Leave it for several days.





Observation:

The plumule grows upwards and the radicle grows downwards.

Conclusion:

The stems are negatively geotropic, while the roots are positively geotropic.

Explanation:

In the normal vertical position:

Auxins are equally distributed in the tips of both root and stem. As a result, the stem grows vertically upwards, while the root grows downwards.

In the horizontal position:

Auxins accumulate in the lower side of both the root and the stem:
In the stem: Auxins activate the cells of the lower which elongate more than those of the upper side. So, the tip of the stem curves upwards against gravity.

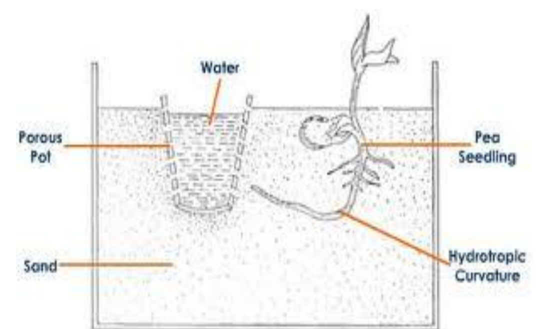
In the root: Auxins inhibit the elongation of the cells of the lower side, so the cells of the upper side elongate more. So, the root bends downwards.



The increase in auxins concentration –to a certain extend- inhibits the elongation of the root cells, while it activates those of the stem.

C. Hydrotropism:

Experiment:



1. Germinate a number of seeds in two glass troughs containing equal quantities of dry soil.

2. Spray water regularly in the first trough, but only at the sides in the second trough.

3. Leave the two troughs for several days.

Observation:

Roots in the first trough grow straight down, while roots in the second trough grow towards the water at the sides of the trough

Conclusion:

In the first trough (A):

The roots grow vertically due to the equal distribution of water in the soil around the roots.

In the second trough (B):

Curvature of roots is due to the presence of water at the sides and its absence in the middle. Auxins accumulate in the side of the root facing water, and inhibits the elongation of cells of that side, while the cells of the far side continue their normal growth which leads to curvature of the root towards water.

The root is known to be positively hydrotropic.

*** Compare between geotropism and phototropism**

P.O.C	Phototropism	Geotropism



1. Stimulus	1. Light	1. Gravity
2. Response of the root	2. –ve	2. +ve
3. Response of the stem	3. +ve	3. –ve
4. Explained by	4. Went	4. Herman exp.
5. Reasons	*5. Migration of auxins from the light side to the dark side that grows faster leading to bending of stem towards light. In the root, the side facing light contains low conc. of auxins, so it grows faster and bends away from light.*	*5. Migration of auxins towards the gravity. In the stem the lower surface contains more auxins so it grows faster and move upwards. In the roots, the upper part contains less auxin, so it grows faster and moves downwards towards the gravity.*

Nervous & Hormonal Coordination



The nervous and the endocrine glands systems control all the body activities in Man. The two systems together organize the functions of different body organs and control the relation between Man and his environment. **The hypothalamus** which is a part of the brain is considered as a link between the nervous system and the endocrine glands system:

The Nervous System and Sensation in Man

In addition to the control of all functions of Human's body systems, the nervous system receives information in the form of external and internal stimuli through receptor systems, and then gives the proper responses. It keeps the Human body in a continuous direct communication with his external and internal environments. This helps, with the endocrine glands system, to keep the internal conditions of the body in an ideal, constant, and balanced state (**Homeostasis).** The nervous system is highly developed in vertebrates, especially in man.

The nervous system is divided into:

1. The central nervous system:

That includes the **brain** and the **spinal cord.**

2. The peripheral nervous system:

That includes **the cranial nerves and the spinal nerves.**

3. Autonomic nervous system:

That controls the involuntary muscles and the glands. This system is sub-divided into:

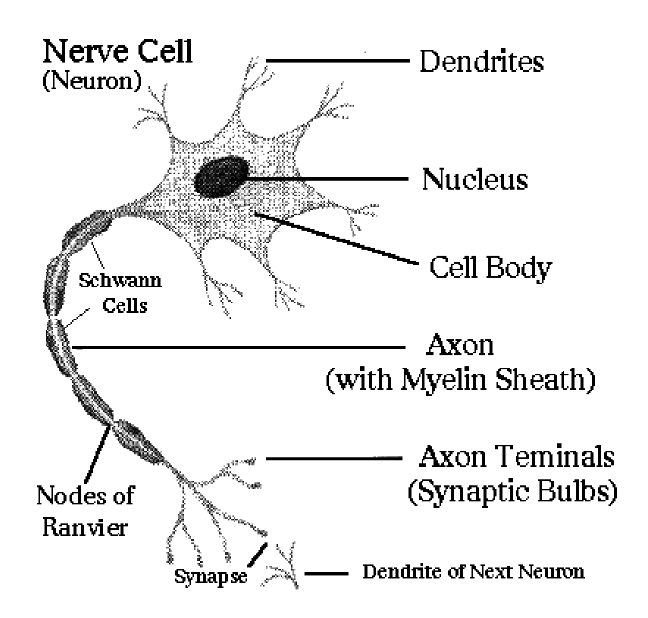


a. **Sympathetic nervous system:** The nerve fibers of this system originate from the thoracic and lumbar region (segments) of the spinal cord.

b. **Parasympathetic nervous system:** The nerve fibers of this system originate from the brain and the sacral region of the spinal cord.

The nerve cell (neuron):

The nerve cell is the unit of structure of the nervous system. Its small in size and cannot be recognized by the naked eye. It consists of:



1. The cell body:

It contains rounded nucleus surrounded by cytoplasm (neuroplasm). The neuroplasm contains neurofilaments and Nissl granules (which are unique for nerve cells). Nissil granules are



considered as a stored food for the cell. The neuroplasm contains all other cell's organelles as mitochondria, and Golgi bodies, except the centrioles (That is why neurons cannot divide)

2. Cell processes:

a. Dendrites:

Dendrites are short processes which increase the surface area available to receive nerve impulses and through which most nerve impulses enter to the cell, while some of which enter to the cell through the cell body.

b. Axon:

It is a long cytoplasmic extension of the cell (may reach more than a meter in length) and usually known as the nerve fiber. In some nerve cells, the axon is surrounded by a sheath of lipid called myelin sheath secreted by special cells called Schawnn's cells. The outer cover of the axon (nerve fiber) is the neurolemma. The myelin sheath is not continuous around the axon but interrupted at certain points called nodes of Raniver.

The conduction rate of verve impulses in myelinated axons (covered with myelin sheath) is much more rapid than in non-myelinated nerve fibers (axons) because the myelin sheath is an insulator.

Normally, the nerve impulse is propagated and conducted through the nerve cell in one direction only, from the dendrite to the nerve cell body to the axon, then to another next neuron (nerve cell) through a synapse. The axon ends in a group of branches called terminal arborizations.

Types of nerve cells:

According to the function, nerve cells are classified into three types:

1. Sensory neurons: Convey (transmit) impulses from receptors to the central nervous system.

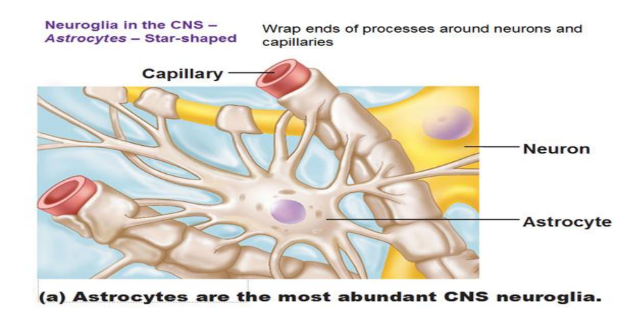
2. Motor neurons: Convey impulses from the central nervous system to the effectors organs as muscles and glands.

3. Connector (intermediate) neurons: Relay impulses from sensory to motor neurons.



Neuroglia:

Another type of cells in the nervous system, have the ability to divide and perform the following functions:

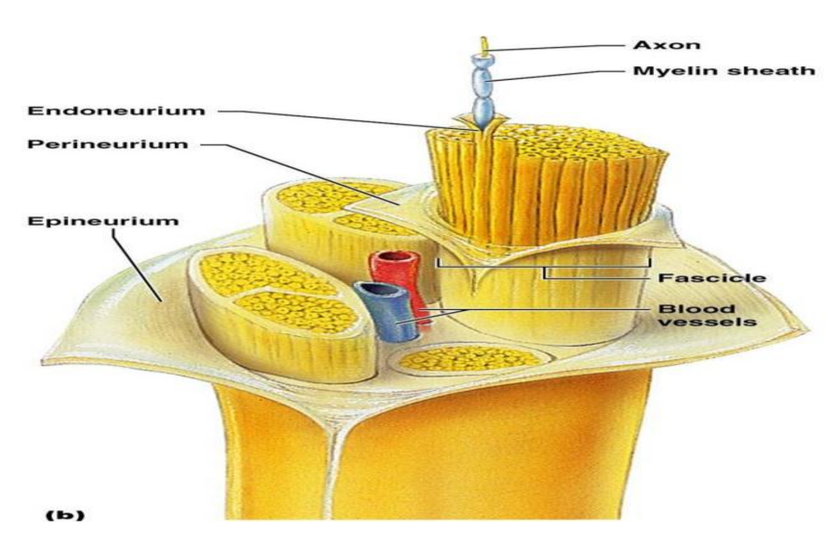


(a) Astrocytes are the most abundant CNS neuroglia.

1. ***They act as a connective tissue to support neurons.***
2. ***They act as insulators between neurons.***
3. ***Nutrition of the neurons.***
4. ***Have a role in repair of injured parts of some neurons.***

The structure of the nerve:

The nerve consists of a group of nerve bundles, each of which is surrounded by a connective tissue sheath. The whole nerve is surrounded by another connective tissue called epineurim which contains blood vessels. Each nerve bundle is formed of a group of nerve fibres (axons) and connected by supporting neuroglia cells (glial cells)





The nerve impulse:

The nerve impulse is the message transmitted through the nerves from sense oragns (receptors) to the central nervous system, and from the latter to the effectors (responding) organs. It is an electrical phenomenon with a chemical nature (electro-chemical phenomenon). To understand the nature of the nerve impulse, we should study the nerve cells (neurons) during 4 different conditions:

1. The nerve cell at rest:

At rest, there is a difference in distribution and concentration of some ions outside and inside the nerve cell, as follows:

a. The concentration of positive Sodium ions ***(Na+)*** *outside the cell is 10 up to 15 times higher than inside.*

b. The concentration of positive Potassium ions ***(K+)*** *inside the cell is 30 times higher than outside.*

c. The concentration of negative ions as Chloride ***(Cl-)*** *and protein ions are higher inside the cell.*

This unequal distribution of ions results in the presence of an electrical potential difference between outside and inside the cell

surface that equals – 70 millivolt (mV). The membrane of the nerve cell during this resting condition is said to be polarized.

This state of polarization is a result of:

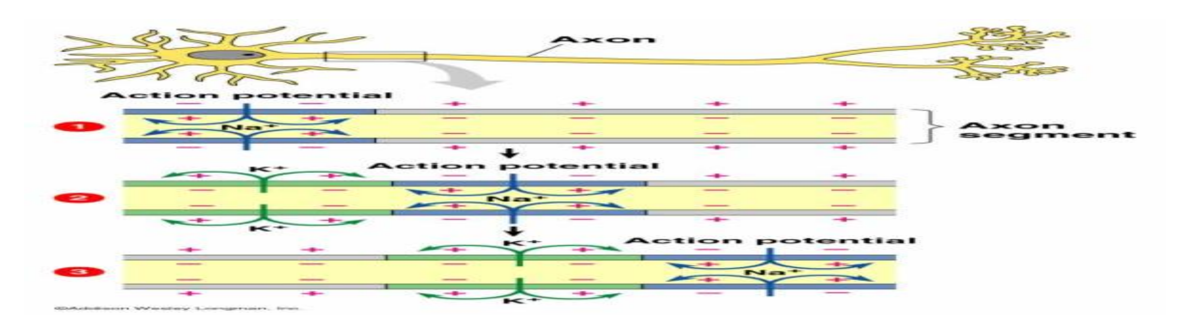
1. The selective permeability of the membrane (at rest), as the membrane of the nerve cell is 40 times permeable for Potassium ions (K+) (which diffuse from the inside to the outside of the membrane) than for Sodium ions (Na+) (which diffuse from outside to the inside of the membrane). This results in the accumulation of excess positive charges on the outer surface of the membrane.



2. Accumulation of high molecular weight protein ions in addition to Chloride ions which are negatively charged on the inner side of the membrane.

3. Sodium-Potassium pump (that pumps Sodium ions actively outside the
membrane, and pumps Potassium ions actively inside
the membrane) which plays a role in maintaining this ionic distribution.

Therefore, at rest there is an accumulation of positive Potassium ions outside the membrane, and negative protein and Chloride ions inside the membrane.



2. Changes in the nerve cell on stimulation:

The nerve cell is stimulated only when the stimulus is sufficient (strong enough). There are changes in permeability of
the membrane in which:

a. The inflow of the positively charged Sodium ions exceeds the outflow of the positively charged Potassium ions through special channels in the membrane leading to accumulation of excess positive charges inside the membrane, i.e. reverse of the original polarity and the membrane potential becomes +40 mV. This new state is called depolarization.

3. Propagation of nerve impulse through the nerve fibres:

The depolarized (stimulated) point acts as a stimulus for



the neighbouring points which when stimulated undergo the same previously mentioned changes, and the process is repeated along the nerve fiber.

4. How the nerve cell returns to its original state:

1. After the end of depolarization, the membrane becomes again permeable to Potassium ions and impermeable to Sodium ions.

2. Continuous out flow of Potassium ions leads again to accumulation of excess positive ions outside the membrane and the membrane is said to be repolarized, i.e. returns to the resting state again (-70 mV). The response of the nerve cell to the stimulus is called action potential (110 mV) which includes a state of depolarization followed by repolarization.

The nerve impulse is the propagation of the action potential along the nerve cell (fiber)

3. *Refractory period: from 0.001 up to 0.003 second following the stimulation, the nerve cell will not respond to any stimulus whatever its strength. This period is called the refractory period. During this period, the membrane of the nerve cell regains its physiological properties to be ready to respond to new stimulus and to transmit another nerve impulse.*

Properties of the nerve impulse:

1. The speed of propagation of the nerve impulse along a nerve fibre depends on its diameter:

- It reaches 140 meters/second in thick (myelinated) nerve fibres.

- It reaches 12 meters/second in thin (non-myelinated) nerve fibres.

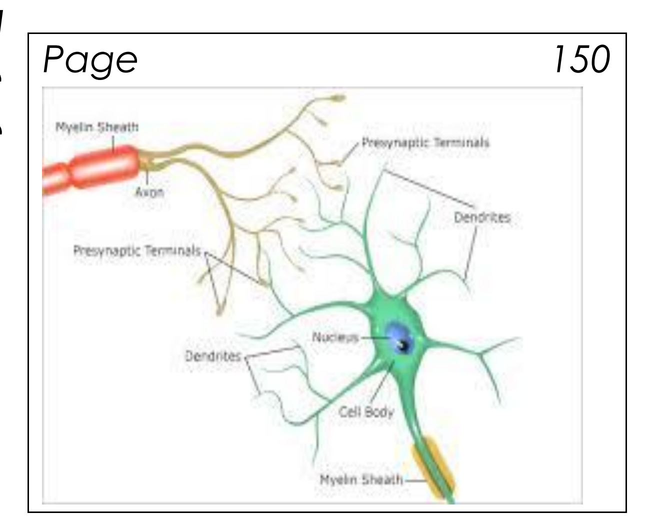
2. Stimulation of the nerve (and also muscles) obeys the ***all or none law,*** *which means that the nerve responds maximally or does not respond at all; the sufficient stimulus produces a maximum response (generation of a nerve*



impulse), after which, the response does not increase whatever the stimulus strength increases. Weak stimuli are insufficient to produce an action potential (nerve impulse).

The synapse:

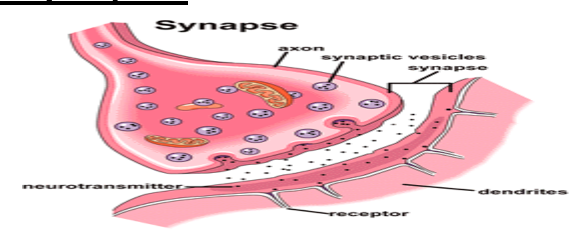
It is site between the terminal branches (arborizations) of the axon of one neuron and the dendrites of the next neuron.



Types of synapses:

1. Synapse between two neurons.
2. Synapse between a neuron and a muscle fibre.
3. Synapse between a neuron and gland cells.

The structure of the synapse:



The terminal branches of the axon end with swellings called buttons which are very close to the dendrites of the next neuron. In between, there is a very narrow space called the synaptic cleft. This cleft separates a presynaptic membrane (axon) from a postsynaptic membrane (dendrite). The synaptic button contains small vesicles (sacs) called synaptic vesicles, filled with chemical transmitters as Acetylcholine and Noradrenalin which play an important role in synaptic transmission of the nerve impulse from one neuron to the next.

Mechanism of transmitting a nerve impulse across a synapse:



1. Arrival of a nerve impulse to the buttons leads to entrance of Calcium ions by the action of a Calcium pump in the cell membrane. The inflow of
Calcium ions leads to rupture of the synaptic vesicles and
the release of the chemical transmitters.

2. The chemical transmitters cross the synaptic cleft and reach the membrane of the dendrites of the next neuron.

3. Binding of the chemical transmitters to special receptors on the membrane of the dendrites leads to stimulation of these points and changes the permeability of the membrane to Sodium and Potassium ions. These results in depolarization and the production of an action potential (nerve impulse) as mentioned before. This nerve impulse is propagated through the body, then the axon of the neuron, then to a next synapse, and so on.

4. Acetylcholine (chemical transmitter) is destroyed (after performing its function) under the effect of an enzyme called cholinesterase to terminate its action. Then, the postsynaptic membrane (dendrite) returns to the resting state again.

The Central Nervous System (C.N.S)

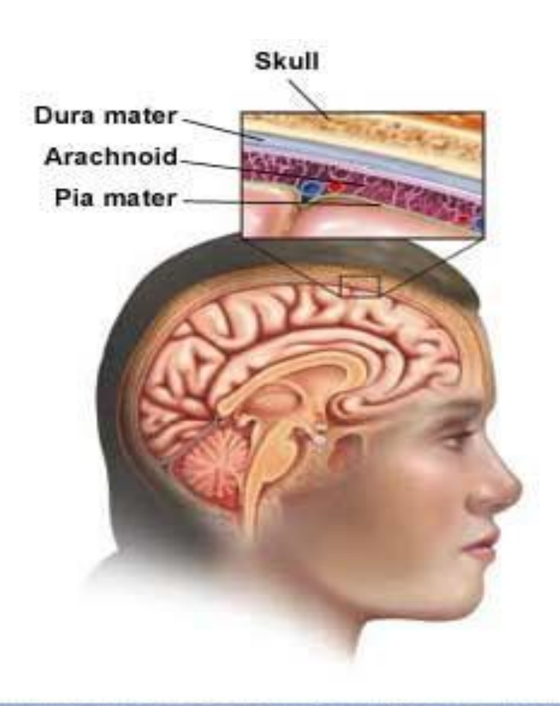
A) The brain:

The brain constitutes the major part of the central nervous system, with a weight that ranges from 350 grams at birth, and reaches 1400 grams in adults. The brain occupies a bony space called the brain case or the cranium (a part of the skull).

The brain is surrounded by three membranes called

the meningies which are responsible for the protection and nutrition of the brain cells. These membranes are:





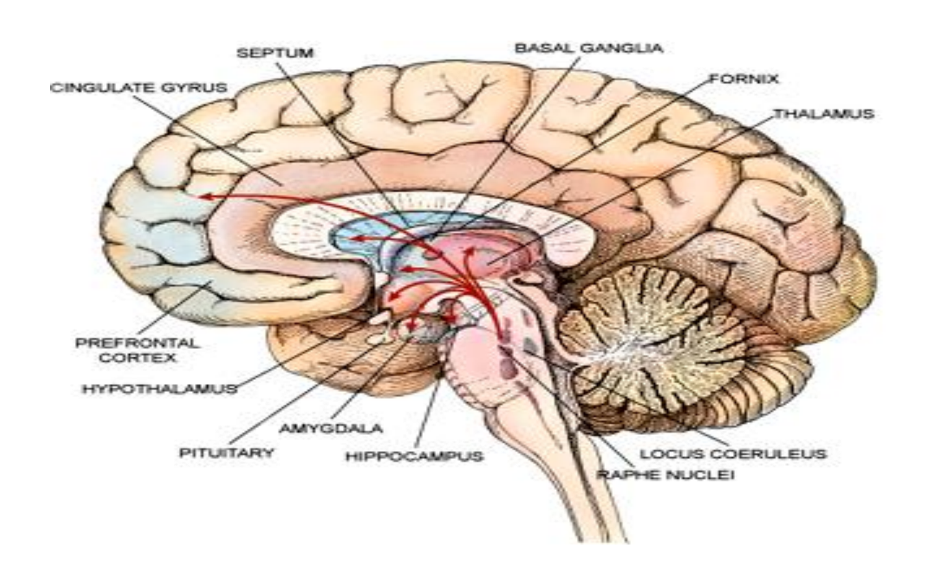
1. **The dura mater**: The membrane which lines the skull.
2. **The pia mater**: The membrane which is in direct contact and adheres to the brain.
3. **The arachnoid**: The membrane which is in between the other two membranes and contains a transparent fluid to protect the brain from mechanical trauma.

<u>The brain consists of three main parts:</u>

1. **<u>Forebrain:</u>** It includes the two cerebral hemispheres (the brain cortex), thalamus, and hypothalamus.
2. **Midbrain.**
3. **Hindbrain:** It includes the cerebellum, pons Varolii, and medulla oblongata.

12 pairs of cranial nerves originate from the brain.





The structure and the function of each part of the brain:

1. Forebrain:

a. Two cerebral hemispheres (the cerebral cortex):

Two big lobes separated by a big fissure and attached to each other through a big bundle of nerve fibres. Each lobe is called

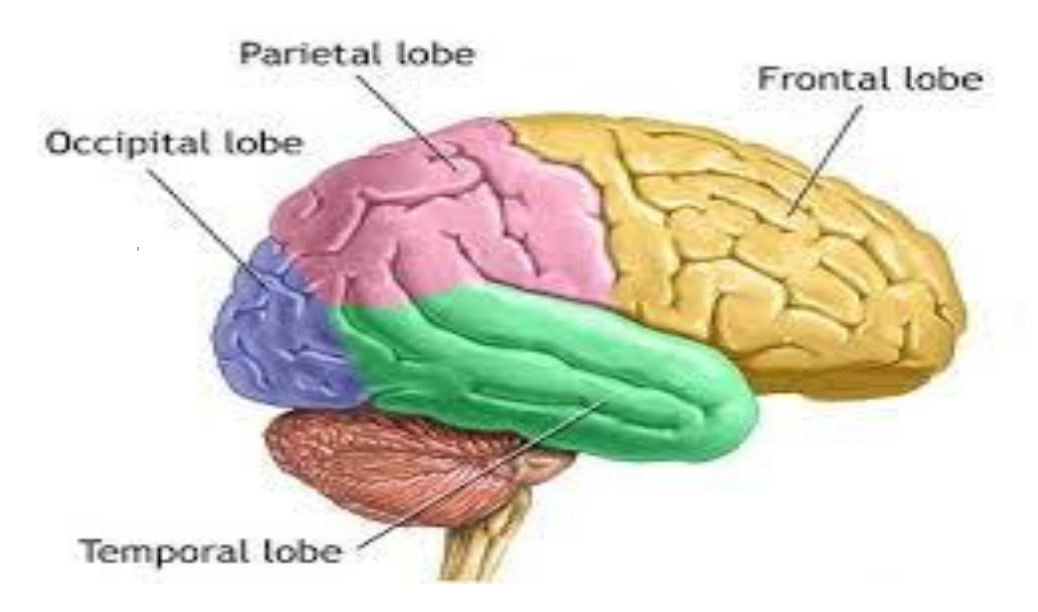
a cerebral hemisphere. The cortex of each lobe (the cerebral cortex) is characterized by the presence of depressions of different depths called fissures and grooves, and in between there are folds.

Each cerebral hemisphere is divided into many lobes. These lobes are:

1. Frontal lobe.
2. Parietal lobe.
3. Temporal lobe.
4. Occipital lobe.

In addition, there is a 5th. Lobe covered by the frontal and parietal lobes





<u>The functions of the cerebral cortex:</u>

a. The frontal lobe contains centres of voluntary movements (motor centres), centre of memory and speech.

b. The parietal lobe controls many sensory functions and contains centres of sensation of heat, cold, pressure, and touch (somatic sensations from the skin)

c. The occipital lobe contains centres of vision.

d. The temporal lobe contains centres of smell and also centers of speech.

b. Thalamus:

Thalamus is an important centre for coordination of different sensations (except the smell).

c. Hypothalamus:

Hypothalamus controls different reflexes and contains centres of hunger, satiety, thirst, and body temperature regulation, in addition to centre of sleep.

2. Midbrain:

The smallest part of the brain, and represents a connection between the forebrain and the hindbrain, and contains centres of equilibrium and centres related to hearing and vision. In addition, it regulates many reflexes as those related to hearing.



3. Hindbrain: It consists of:

a. Cerebellum:

That is situated in the posterior region and consists of three lobes. The main function is to keep balance and equilibrium of the body in association with the inner ear and muscles.

b. Pons Varolii and medulla oblongata:

That performs the following functions:

1. Transmission of nerve impulses between the spinal cord and different brain regions.

2. The medulla oblongata contains vital centres as those of respiration, swallowing, vomiting, cough, sneezing, and blood vessels.

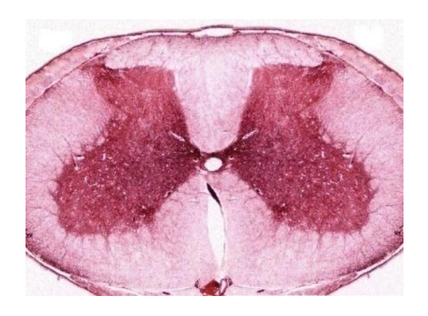
B) The spinal cord:

The spinal cord exists inside a canal in the vertebral column called **the neural canal.** It extends from the medulla oblongata in the form of a cylindrical cord about 45 cm long. The spinal cord is hollow containing a central canal and covered by meningies as those surrounding the brain (dura mater, pia mater, and arachnoid). Along the midline there are two fissures (dorsal, and ventral) which divide the spinal cord incompletely into two halves. The spinal cord consists of 2 layers; outer white matter formed of nerve fibers and inner grey matter formed of nerve cells with their dendrites and neuroglia. Gray matter is H-shaped with two dorsal horns and two ventral horns.

Functions of the spinal cord:

The grey matter is the main center of reflex action as it contains thousands of reflex arcs. The white matter transmits impulses from different parts to the brain and vice versa.





Spinal nerves:

There **are 31 pairs** of spinal nerves that originate as successive pairs from both sides of the spinal cord as follows:

1. Eight pairs of cervical nerves.

2. Twelve pairs of thoracic nerves.

3. Five pairs of lumbar nerves.

4. Five pairs of sacral nerves.

5. One pair of coccigeal nerves.

Each spinal nerve originates from the spinal cord by two roots (dorsal, and ventral). The dorsal root carries sensory nerve fibers that transmit impulses from the receptors to the spinal cord and then to the brain. The ventral root carries motor nerve fibers that transmit impulses to the responding organs (effectors) as muscles and glands.

Peripheral Nervous System

This system consists of a network of nerves distributed all over the body connecting the central nervous system to all parts of the body. These nerves are of two types:

1) Cranial nerves:

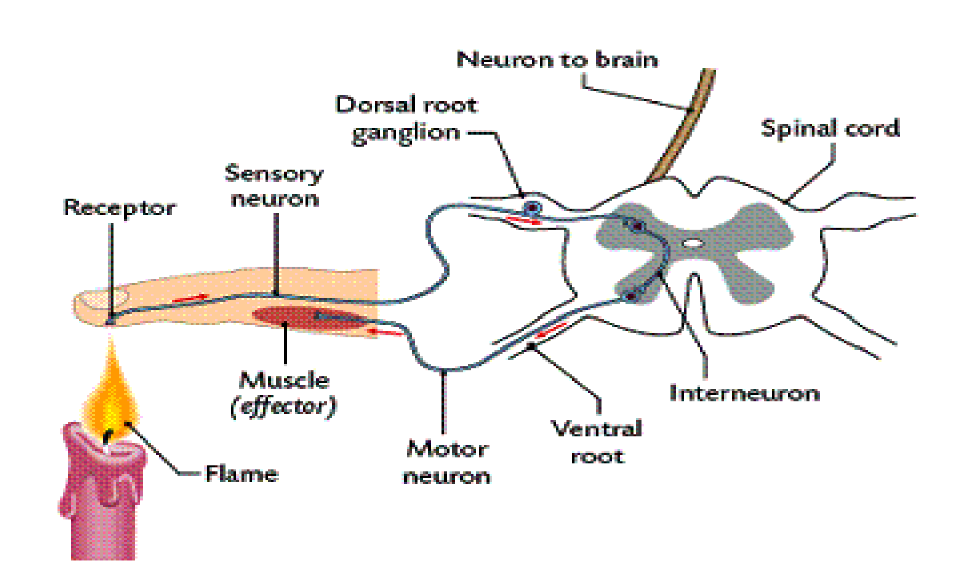
12 pairs connected to the brain:



a. Some cranial nerves are purely sensory containing sensory fibres only and carry impulses from receptors to the brain.
b. Others are purely motor containing motor fibres only and carry impulses from the brain to the effecter organs.
c. Some cranial nerves are mixed with both motor and sensory fibres.

2) Spinal nerves:

31 pairs connected to the spinal cord and these are mixed nerves with both sensory and motor fibres.



The reflex action (reflex arc):

The reflex action is the unit of nervous activity. The majority of the nervous functions can be analyzed to a group of reflex actions at different levels.
The reflex action consists of at least two nerve cells (neurons), one sensory (afferent) and the other is motor (efferent).

The majority of reflex actions consist of 5 elements:

1. Receptor (sense organ)
2. Afferent (sensory) neuron.
3. Connector (intermediate) neuron.



4. Efferent (motor) neuron.

5. Effector (responding) organ.

Reflex actions are of two types:

a. Voluntary (somatic) reflex: In which effector organ is a voluntary (skeletal) muscle.

b. Involuntary (autonomic) reflex: In which the effector organ is an involuntary muscle, a gland or the heart muscle.

Autonomic Nervous System

This system regulates the different involuntary activities as contraction of cardiac muscle and smooth (involuntary) muscles in addition to secretion of glands.

The autonomic nervous system includes two divisions:

1) Sympathetic nervous system:

The nerve fibres of this system originate form the thoracic and lumbar regions of the spinal cord. This system is important as an emergency system which enables the body to confront emergency situations.

2) Parasympathetic nervous system:

The nerve fibers of this system arise from the brain (stem) and the sacral region of the spinal cord. Most of the internal parts of the body receive nerve fibres related to both sympathetic and parasympathetic systems and in most cases the effort of one system antagonize the effect of the other.

Effects of autonomic nervous system on some parts of the body



Parasympathetic

Sympathetic

Stimulates flow of saliva

Ganglion

Medulla oblongata

Slows heartbeat

Vagus nerve

Constricts bronchi

Stimulates peristalsis and secretion

Stimulates release of bile

Contracts bladder

Chain of sympathetic ganglia

Dilates pupil

Inhibits flow of saliva

Accelerates heartbeat

Dilates bronchi

Solar plexus

Inhibits peristalsis and secretion

Conversion of glycogen to glucose

Secretion of adrenaline and noradrenaline

Inhibits bladder contraction

<u>The following table summarizes the effects of the sympathetic and parasympathetic system on some parts of the body :</u>

Effector organ	Effect of Sympathetic system	Effect of Parasympathetic system
Heart	*Increases heart beat rate and force of contraction.*	Decreases heart beat rate and force of contraction.
Blood vessels	*Vaso constriction of blood vessels of skin, viscera, salivary glands, brain,*	Vaso relaxation of salivary glands and external genetalia.



	external genetalia and lungs.	
Alimentary canal	*Relaxation of the wall of stomach, intestine and colon.*	Contraction of the wall of stomach, intestine and colon.
Respiratory system	*Dilatation (relaxation) of bronchioles and decreases secretions.*	Constriction (contraction) of bronchioles and increases secretions.
Urinary bladder	*Relaxation of the wall.*	Contraction of the wall.
Eyes	*Dilatation of the eye pupils.*	Constriction of the eye pupils.
Glands:		
1. Salivary	*Stimulates small quantity of secretion.*	Stimulates large quantity of secretion.
2. Gastric (of the stomach)	*Inhibits secretion.*	Stimulates secretion.
3. Liver	*Break down of Glycogen and increases Glucose level in blood.*	No Parasympathetic fibres.
4. Pancreas	*Inhibits secretion of enzymes.*	Stimulates secretion of enzymes.
5. Adrenal medulla	*Stimulates the secretion of the adrenaline hormone (epinephrine) which increases blood pressure, increases heart beat rate, and increases the Glucose level in the blood.*	No Parasympathetic fibres.

Chapter (5) question

Write the scientific terms:-

1-A suitable response to the different stimuli to keep the life of the living organism(...................).

2-The curvature of roots or stem as a response to different stimuli(..................).

3-The response of plant to light which is considered as external stimulus (......................)

4-The chemical compound which is secreted from the tip of plant and affected by external factors (..............................).

5-A Chemical compound which is secreted from the tip of plant and translocate to the responding region (.............................).

6-The system which control the function of human body (..........................).

7- A group of long nerve axons (........................).

8-The state of nerve fibers when external surface is positive and internal surface is negative (..............................).

9-Three membranes surround the brain to protect and feed its cells (………………….).

10-A membrane lines the skull from the inside. (.........................).

Complete the followings:-

1-The concentration of auxins in dark side of the plant stem is .... in the light side.

2-................. is the factor which causes the geotropism.

3-The root is.................... phototropism.

4-Sensory cells link ....with the brain.

5-The nerve fibers represents ....

6-The nerve represents ....

7-.................is the center of reflex action.

8-.................regulate the sensory of reflex action.

9-The number of cranial nerves = ...



10-The length of spinal cord =……… Cm

Give Reason For:-

1-The response of Mimosa plants to touch and darkness.

2-Presence of swollen structure at the base of each rachis of Mimosa plant.

……………………………………………………………………………………………

……………………………………………………………………………………………

3-Roots of plants are positive (Hydrotropism-Geotropism) and negative phototropism.

……………………………………………………………………………………………

……………………………………………………………………………………………

4-Presence of nissil granules in the nerve cell.

……………………………………………………………………………………………

……………………………………………………………………………………………

5-Some nerve axons are surrounding by myelin sheath and Schwann cell.

……………………………………………………………………………………………

……………………………………………………………………………………………

6-A lesion or an injury nervous center can be healed.

……………………………………………………………………………………………

……………………………………………………………………………………………

7-The nerve cell always needs the acetylcholine substance.

……………………………………………………………………………………………

……………………………………………………………………………………………

8-The 5th lobe of cerebral cortex can't be seen by the naked eyes.

……………………………………………………………………………………………

……………………………………………………………………………………………

9-Death of human after strike the medulla oblongata.

……………………………………………………………………………………………

……………………………………………………………………………………………

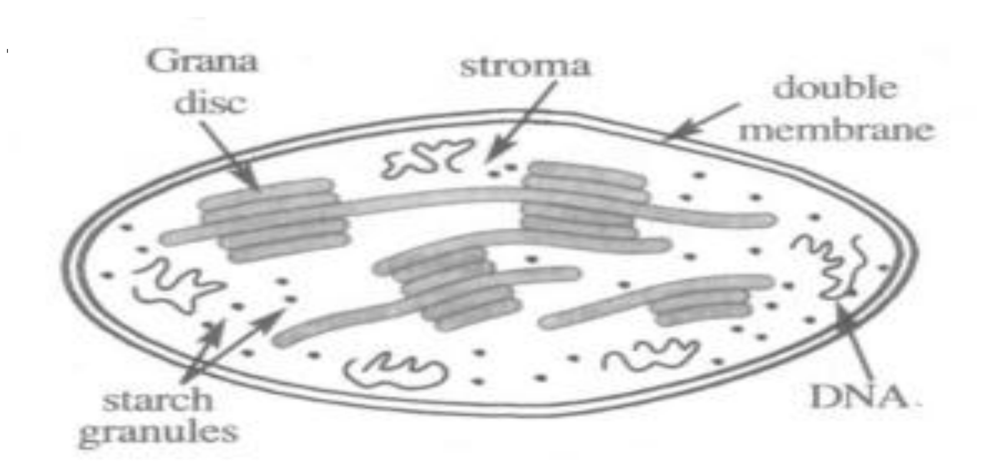
10-The effect of parasympathetic nervous system increase during eating of food.

……………………………………………………………………………………………

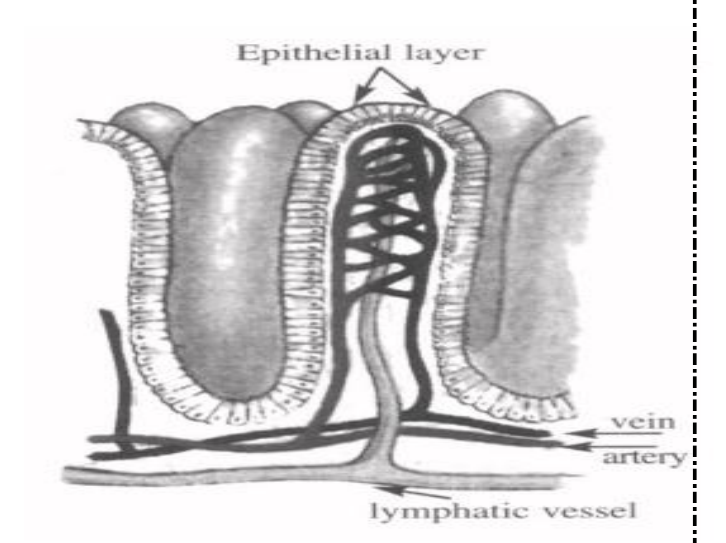
……………………………………………………………………………………………

Biology Practical Exam Revision sheet 2nd Secondary

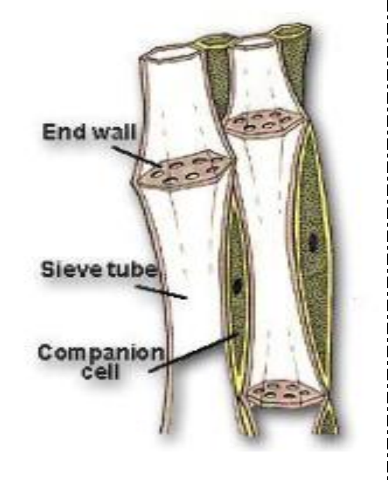
1-The structure of chloroplast- Under the light microscope:-



2-Structure of the villi::-



3- Structure of the Phloem:-





4-Neuron:-

Nerve Cell
(Neuron)

Dendrites

Nucleus

Cell Body

Schwann
Cells

Axon
(with Myelin Sheath)

Axon Teminals
(Synaptic Bulbs)

Nodes of
Ranvier

Synapse

Dendrite of Next Neuron

Structure of Kidney:-

